



GDOT Roundabout Design Guide

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INTRODUCTION

Roundabout design is a performance-based design process, whereby the critical elements of circle size, circle location and alignment of approaches are guided by safety and operational performance criteria. Geometric design follows analysis, which determines the required lane configuration. Safety performance is achieved by geometric design that provides speed control that reduces entry-circulating crashes and establishes priority to circulating traffic. Approach geometry and a visibility package of signs and markings should build driver expectation of speed reduction and yield.

This design guide presents the principles and methods of achieving practical design and optimal roundabout operations through performance-based design. Appendix A provides background nomenclature on the modern roundabout. Appendix B discusses practical design in more detail. Appendix C and Appendix D provide detailed how-to's to undertake design performance checks. Appendix E explains best-practice vertical design methods in more detail.

This document is intended to supplement GDOT Design Policy Chapter 8 and is underpinned by NCHRP 672, ***Roundabouts: An Informational Guide – 2nd Edition***. Where stated values and figures differ from NCHRP 672, this document should take precedent for GDOT design practice.

CHAPTER 1 –CAPACITY AND OPERATIONS

The sizing of a roundabout depends on traffic, geometric, and environmental factors and budgetary constraints, but traffic analysis and determination of lane configuration precedes drawing of a geometric layout. The designer's motto is therefore: "model it first (ops analysis), draw it next (layout follows ops analysis)".

1.1 ROUNDABOUT OPERATIONAL ANALYSIS PROCESS

When sizing a roundabout for the number of entering and circulating lanes, each approach leg of the roundabout is evaluated individually to determine the number of entering lanes that are required based upon the conflicting flow rates. The capacity of a roundabout entry is generally driven by the amount of conflicting traffic (vehicles traveling along the circulatory roadway) that is present at each roundabout entry. High conflicting volumes reduce the number of opportunities for vehicles to enter the roundabout and therefore reduce the capacity of a particular approach leg. Conversely, where low conflicting traffic volumes are present, the approach leg will have a higher capacity and allow for a higher number of vehicles to enter the roundabout.

The workflow for performing roundabout operational analyses is listed below. Analyze both AM and PM peak hours and perform the analysis for the Build Year, Build Plus Ten and the Design Year forecasted traffic. Development of the required lane configuration should be an iterative process to determine the appropriate number of lanes and lane assignments by checking Level of Service (LOS) results until they are within the acceptable and a desirable range

1. Gather Volumes, PHF and Truck %
2. Enter forecasted volumes into GDOT roundabout analysis tool (see section 1.3.1) and analyze as a single-lane roundabout. (Check the criteria for use of the GDOT Tool – see Section 1.3)
3. Do the results report an acceptable LOS per approach in the Design Year?

	Yes	No
<ul style="list-style-type: none"> • LOS E in urban areas • LOS D in rural areas • Check Build and Build plus 10 years 	Report on operational analysis	Add additional lanes or right-turn bypasses until results report an acceptable LOS
4. Do the results report a desirable LOS* and V/C ratio <0.85

	Yes	No
<ul style="list-style-type: none"> • If the V/C ratio is >0.85 use alternative software (see Section 1.3) • Check Build and Build plus 10 years 	Report on operational analysis	Re-analyze in a second analysis software to verify lane configuration (see Section 1.3). Add additional lanes or right-turn bypasses until results report a desirable* LOS

(*See GDOT Design Policy Manual)
5. Confirm number of entry lanes and lane configuration and draw a lane configuration sketch, e.g. Figure 1-1

1.2 DETERMINE NUMBER OF ENTRY LANES AND LANE CONFIGURATION

A rule of thumb for determining the number of entry lanes of a roundabout entry is: if the sum of the entering and circulating volumes for each approach is less than 1,000 veh/h, then a single-lane roundabout is likely to operate acceptably. Exhibit 3-14, NCHRP 672 provides volume thresholds for determining the number of entry lanes required. The number of lanes within the circulatory roadway is then the number of lanes needed to provide lane continuity through the intersection. Section 3.5.1, NCHRP 672 provides guidance on developing planning estimates of lane requirements. It is practical and beneficial to determine the approximate lane requirements before undertaking a more detailed software analysis.

Starting with the design year traffic turning movements, begin the analysis with a single-lane roundabout and add lanes as needed to achieve an acceptable LOS for design year operations in both peak periods. Consider adding right-turn bypasses before creating multilane entries. An exception to this is when the corridor is already multilane, in which case, the roundabout can start out as multilane to maintain lane continuity.

Four operational performance measures are typically used to estimate the operational performance of a particular roundabout entry: volume-to-capacity ratio, control delay, LOS, and queue length. A roundabout should be designed to have an acceptable LOS per approach by design year. LOS E, or 35 seconds of delay, is the recommended threshold in the design year, as it requires anticipation of the need to expand the layout close to the design year.

In order to account for the functional area of the roundabout in terms of operations, the analyst should be aware of driveways near the roundabout (see Section 2.5). Queue length is important when assessing the adequacy of the geometric design of the roundabout approaches. The approach roadway should have adequate storage capacity so that the queue does not obstruct driveway access, another intersection or other approach lanes.

In some situations, a multilane design is required for acceptable design year operations, but the analysis indicates fewer lanes are needed for the build year or shortly after. If a single-lane roundabout or a partial multilane roundabout will provide sufficient capacity for the Build Year and approximately ten (10) years, designers should construct and operate the roundabout in a reduced lane configuration until traffic volumes dictate the need for conversion/expansion. When considering an expandable roundabout, the designer should evaluate the right-of-way and geometric needs for both the interim and ultimate lane configurations.

If a two-lane entry is required, document the entry volumes for each lane of the roundabout approach. Adjust lane arrow assignments based on observed or estimated lane utilization patterns or imbalances. Alternatives (Figure 1-1) could include adding a right-turn lane, adding a left-turn lane, using shared left-through for the inside lane and shared through-right for the outside lane, or dual left turning lanes. If lane demands are unbalanced, the observed or estimated percentage of lane use needs to be accounted for in the analysis tools.

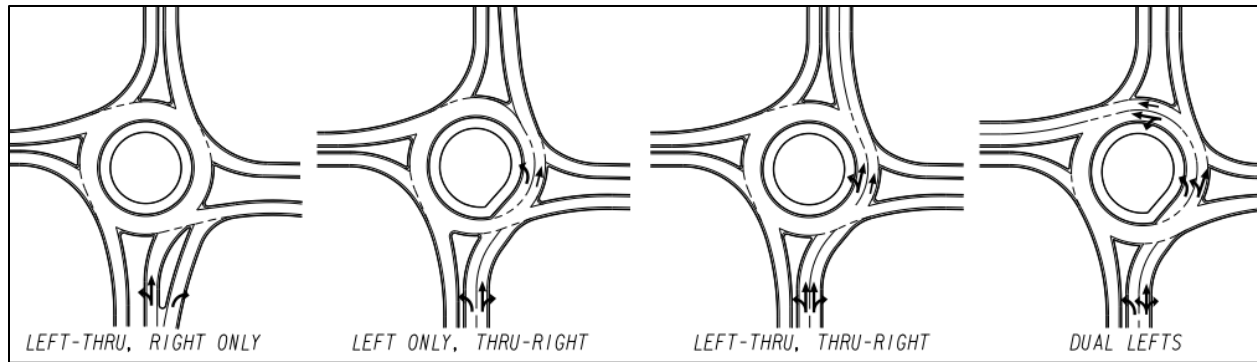


Figure 1-1. Lane Configuration Options for Two-lane Entry

The following are three common pitfalls stemming from the initial roundabout analysis that can lead to impractical and more expensive designs:

1. Traffic forecasts that overestimate traffic growth and indicate more lanes will be needed too soon.
2. Capacity models that are very “conservative” and indicate failure of a single-lane design sooner than in reality.
3. Design horizons that are inappropriately long for the project or site context.

Being overly “conservative” in some or all of these areas can lead to a roundabout that is more expensive and potentially less safe than it should be. This reinforces the requirement to verify the lane configuration needs through the operational analysis prior to beginning geometric design.

1.3 OPERATIONAL ANALYSIS SOFTWARE

The Georgia DOT Roundabout Analysis Tool and the SIDRA Intersection Software are both acceptable for use as a design and evaluation aid for roundabouts. Use of the GDOT Analysis Tool (HCM6, Chapter 22 Roundabouts) is impractical if any of the following conditions exist:

- When the proposed roundabout is adjacent to a traffic signal (within 500ft.)
- Where high pedestrian crossing activity is expected (>100peds/h) More than two (2) entry lanes on any approach
- More than four (4) legs on the roundabout
- Entries with flared lanes, e.g. one (1) to two (2)
- When the V/C ratio is > 0.85

Under these conditions, the analyst should use another roundabout capacity model and conduct sensitivity analysis (e.g. GDOT Roundabout Analysis Tool versus SIDRA or another analysis tool). The analyst should run each additional capacity model with varied flows and/or by varying the geometry, e.g. number of lanes. By doing so the analysis will be robust and account for weaknesses in the traffic forecasts, models and/or geometry.

It is recommended to consult with the Office of Traffic Operations if conducting sensitivity and/or expandable design analysis. Send an email to: roundabouts@dot.ga.gov

GDOT’S ROUNDABOUT ANALYSIS TOOL

GDOT’s Roundabout Analysis Tool is an Excel workbook containing an analysis spreadsheet for mini, single-lane, and multilane (up to two lanes) roundabout configurations, which can be found under the following link:

<http://www.dot.ga.gov/DriveSmart/SafetyOperation/Documents/Roundabouts/AnalysisToolv4-1.zip>

The tool applies methodologies from the Highway Capacity Manual (HCM) 2010 Edition for mini roundabout analysis. HCM 6th Edition, Chapter 22 methodologies are applied for single-lane and two-lane roundabout analysis. Detailed instructions are located in the workbook. Inputs include volumes (entered as origin destination pairs), peak hour factor (PHF), and truck percentages. Results include entry capacity, approach V/C ratio, approach delay, approach level of service (LOS), and 95th percentile queue. It has an option to analyze a right-turn bypass lane.

SIDRA INTERSECTION

SIDRA Intersection is a software tool that is capable of running multiple different roundabout capacity models including the HCM 2010 and HCM 6th Edition models, as well as a proprietary SIDRA Standard model. The SIDRA Standard roundabout capacity model is a gap-acceptance theory, lane-based, “micro-analytical” model originating from Australian research. Where a secondary capacity model is desired to compare against the results from the GDOT Roundabout Analysis Tool, GDOT’s preference is to apply the SIDRA Intersection software running the SIDRA Standard roundabout capacity model. See Figure 1-2 for typical SIDRA software inputs. Information in the Options tab should follow guidelines from the DPM. Information in the Roundabout Data tab should be adjusted for site-specific conditions. Use Environmental Factor of 1.1 for Build Year and 1.05 for Design Year analysis.

Options | Roundabout Data

Roundabout Model Options

Roundabout Capacity Model

- ☒ SIDRA Standard
- ☐ US HCM 6
- ☐ US HCM 2010

Roundabout Level of Service (LOS) Method

- ☐ SIDRA Roundabout LOS
- ☐ Same as Signalised Intersections
- ☒ Same as Sign Control

Delay Model

- ☒ Exclude Geometric Delay
- ☒ HCM Delay Formula

HCM Roundabout Capacity Model Extension

- ☐ Apply the SIDRA Model for Unbalanced Flow Conditions for HCM 6
- ☐ Apply the SIDRA Model for Unbalanced Flow Conditions for HCM 2010

Other Roundabout Models

- ☐ FHWA 2000
 - ☐ Use Urban Compact Roundabout
- ☐ HCM 2000
- ☐ NAASRA 1986

Site Display

Current Capacity Model: SIDRA Standard

Geometry

Approach:	S	E	N	W
Number of Circ Lanes	1	1	1	1
Circulating Width	20.0 ft	20.0 ft	20.0 ft	20.0 ft
Island Diameter	100.0 ft	100.0 ft	100.0 ft	100.0 ft
Inscribed Diameter	Program ▾	Program ▾	Program ▾	Program ▾
Entry Radius	65.0 ft	65.0 ft	65.0 ft	65.0 ft
Entry Angle	30.0 °	30.0 °	30.0 °	30.0 °
Raindrop Design	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Circulating Transition Line	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Number of Downstream Circ Lanes	Program ▾	Program ▾	Program ▾	Program ▾

SIDRA Standard Roundabout Model Calibration

Approach:	S	E	N	W
Environment Factor	1.10	1.10	1.10	1.10
Entry/Circ Flow Adjustment	None ▾	None ▾	None ▾	None ▾

Figure 1-2. SIDRA Standard Settings

CHAPTER 2 – GEOMETRIC DESIGN

2.1 DESIGN PROCESS AND WORKFLOW

Achieving an optimal roundabout geometry requires a thorough exploration of the ‘design space’: location context, geometric requirements and potential trade-offs of safety with capacity and/or cost. Concept sketching allows initial exploration of feasibility and potential impacts before investing significant effort in detail design elements. The process is summarized to align with the stages of project development as shown on Figure 2-1.

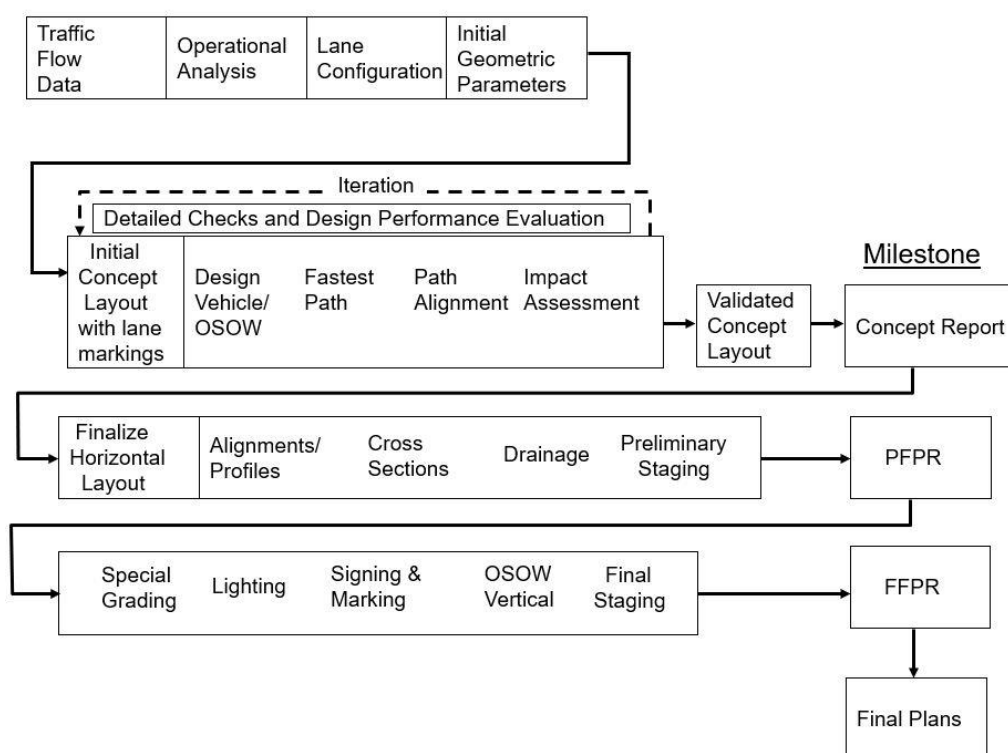


Figure 2-1. Design Process and Workflow

2.2 PRACTICAL DESIGN CONSIDERATIONS

All roundabout designs should practically address the capacity and safety needs of an intersection, but in many cases, cost optimization is necessary and beneficial. The key to practical design is identifying potential competition for right-of-way and cost that ideal geometry can impose.

Practical design is not controlled by a predetermined budget, does not compromise safety, nor eliminate standards and good practice. It does focus on context, need and purpose and emphasizes engineering judgement. It is essentially design optimization with a greater emphasis on balancing cost with capacity and safety. This requires careful consideration of design trade-offs. Designers should consult with the Office of Design Policy and the Office of Traffic Operations when considering possible design variances implied by the list below.

Eliminating lower priority project design elements can result in lower cost and improved value without adverse effect on safety and capacity. Depending on site context, examples might include:

- Remove Excess curb – use curb to only confine trucks and to reduce speeds near the entries and exits rather than along the entire project length
- Reduce splitter island length – use shorter medians with added visibility elements on the approach;
- Reduce excess lighting – use pavement marking reflectors and illuminated bollards instead;
- Remove excess drainage structures – construct rural shoulders and ditches instead
- Avoid multiple construction stages and temporary pavement – employ road closures and off-site detours; and,
- Eliminate pedestrian crossing in rural areas without pedestrian traffic or existing facilities.

Practical design doesn't change the requirement to meet basic design criteria, and the variances/exceptions still needed for not meeting them. However, designers can realize cost savings by utilizing flexibility that exists in current design guidance and standards. Practical design considerations include but are not limited to:

1. Minimizing required Right-Of-Way (ROW) by employing ellipses to mitigate intersection skew angle or avoid adding right-turn bypass channelization.
2. Right-sizing for traffic demands – staged expandability from single lane to multilane.
3. Encompassing existing features such as important trees, landscape or built form, and blends with the profile and existing landscape.
4. Using shorter approach medians without chicanes or offsets, that are balanced and symmetrical without longer tapers upstream.
5. Using flared entry and tapered exit designs that add and drop lanes on approach using flares and exit tapers for lane gains and lane drops. Using single lanes upstream and downstream to add capacity without undue widening on approaches – a wide nodes and narrow roads principle.

Figure B-1, Appendix B provides a diagram of this list and an expanded discussion of practical design and examples of how it can be applied.

2.3 DESIGN CRITERIA

The most important mindset for the practical designer is that operational performance, not geometric conformance, guides the geometric outcomes. It is the overall composition of the design and the resulting performance that matters more than the dimensions of individual elements. Designers must be **strategic** in keeping the 'big picture' roundabout performance objectives in mind and let those objectives guide the selection of individual design details.

Strategic design thinking serves the following high-level core principles. The initial selection of roundabout size (Section 2.5) as well as position and approach alignments (Section 2.6) play a large role in achieving these principles:

- Traffic and lane configuration
- Speed control
- Space for trucks
- Sight distance
- Entry and exit path alignment and channelization, especially with multilane

Details focus on further 'fleshing-out' the design to support the strategic performance goals.

- Lane widths and transitions
- Grading (Section 2.15)
- Intersection sight distance (Section 2.11)

- Lighting (Chapter 5), landscape (Chapter 6), signs and markings (Chapter 4), and cross walks (Chapter 3)

2.4 ROUNDABOUT FUNCTIONAL AREA

Two design zones are defined at a roundabout: the approach zone and the transition zone. The approach zone precedes the roundabout's functional area. Standard design criteria are applied to the approach zone. Exceptions require approval of a design variance. The transition zone, or the roundabout's functional area, begins where vehicles are expected to decelerate from the roadway's posted speed and is thus a reduced speed environment where roundabout design criteria are applied. Refer to Figure 2-7 and Figure 2-8 for an illustration of the functional area.

DRIVEWAY ACCESS/MEDIAN OPENING

Driveways and median openings are not desirable in the areas of splitter islands, except where it is feasible and practical to restrict access. Depending on site context, these are treatment options for consideration:

- Connecting a driveway to the roundabout as a new entry;
- Making a driveway right-in/right-out if the property has additional or alternative ingress/egress
- Providing a median opening, preferably with sufficient median width for left-turn refuge

Driveway turn bays are recommended to clear left turning traffic near a roundabout approach or entry. Splitter islands need to be wide enough to accommodate the turn bay width, otherwise use a median cut-through design.

2.5 CIRCLE SIZE

Selection of a circle size, or Inscribed Circle Diameter (ICD), is dependent on traffic, space available and a combination of other factors (some examples are environmental impacts, utility conflicts, existing roadway configuration, limited ROW, roadway classification, design vehicle swept path, and design speed). The design vehicle generally governs circle size for single lane roundabouts. Table 2-1 provides a range of typical inscribed circle diameters associated with small and large roundabouts. Circle size and approach alignment affect geometric entry speed. In high-speed rural context, the combination of circle size and approach alignment, e.g. left offset, influence roundabout safety performance. Thus, while the designer has flexibility in tailoring a layout to suit space constraints, the safety performance objective for speed control equally governs circle size.

Table 2-1. Roundabout Categories (90° intersections with 4 legs)

Design Element	Mini Roundabout	Single Lane		Multilane Roundabout
		Compact Roundabout	Conventional Roundabout	
Typical inscribed circle (ICD)	70 to 90 feet	85 to 120 feet	120 to 160 feet	150 to 210 feet
Desirable range of geometric entry speed	15 to 20 mph	20 to 25 mph	20 to 25 mph	25 to 30 mph
Central Island Treatment	Traversable central island	Central island plus truck apron		

Single lane and multilane roundabouts may also have partial or full right-turn bypass lanes. Attaining speed control with smaller ICD's expressly requires left offset design of approach alignment.

Mini-roundabouts are defined by their small ICD and fully mountable central islands. With a diameter commonly less than 100 ft., the mini roundabout is made possible by the use of a fully mountable central island to accommodate large vehicles. The small footprint of a mini-roundabout offers flexibility in working within constrained sites. However, as described in NCHRP Report 672, Section 6.6, it also has limitations due to the reduced ability to control speeds and lower visibility to approaching vehicles due to the lack of central island landscaping. See Section 2.17 for more detail on mini roundabouts.

The choice of compact or conventional single-lane roundabout is dependent on space available at an intersection, intersection angle (skew), class/speed of roadways and design vehicle. If an intersection has high-speed approaches and must accommodate a WB-67 for all turning movements, a compact roundabout may not be practical. Typically, a compact roundabout will not accommodate a WB-67 without over-tracking curbs, but in some cases outside over-tracking areas (truck blisters) may be used to compensate for the smaller inscribed circle diameter.

Also, a single-lane roundabout with a compact diameter may be desired when there is significant construction cost and right-of-way constraints. However, use of a compact design needs to be consistent with the site context, lane configuration needs, while still meeting the design performance checks (space for trucks and speed control) and the design year capacity requirements for a single lane roundabout. If capacity analysis indicates that conversion to a multilane roundabout is needed prior to the design year, then a conventional roundabout design should be used with the design explicitly set up for expandability.

Compact diameter roundabouts provide many similar features to conventional single-lane roundabouts, including landscaped central islands. However, the smaller size has tradeoffs related to accommodation of larger design vehicles. For sites where WB-67 size tractor trailers are primarily traveling along the mainline through movements and smaller design vehicles are used for the side streets (e.g. access to a residential subdivision) then a compact design might be able to achieve adequate design vehicle accommodations. However, outside truck aprons maybe necessary for situations such as were WB-67 design vehicles need to make right-turns to or from the minor street.

For conventional single-lane roundabouts at a 90-degree intersection that must accommodate a WB-67 design vehicle for all turns, a range for the inscribed circle diameter is 130 to 150 feet. A good starting point to lay out a single-lane roundabout is with an ICD of 130 feet. ICD may be increased or slightly decreased to accommodate right-of-way, the design vehicle and to control speed. In situations with more than four legs or skewed intersection angles, larger inscribed circle diameters or development of an elliptical shaped ICD and central island may be necessary.

At multilane roundabouts, the ICD is usually determined by balancing the need to achieve deflection and the need to provide smooth alignment of vehicle paths into entries - the natural vehicle paths (See Section 2.14). Typically, the addition of lanes and satisfying both of these design objectives requires a slightly larger diameter than used for single-lane roundabouts.

2.6 CIRCLE LOCATION AND ALIGNMENT OF APPROACHES

Circles should be located to optimize intersection visibility and entry speed reduction balanced from opposing directions. Where there are skewed intersections and space constraints, the circle location and approach alignments may need to be shifted, and the circle shape may also need to be modified, e.g. elliptical shape. Figure 2-2 to Figure 2-5 illustrate common intersection approach alignment conditions designers may encounter and the practical alternative circle shape and approach alignment solutions that should be considered. Left-offset of approach alignment should be achieved in each case.

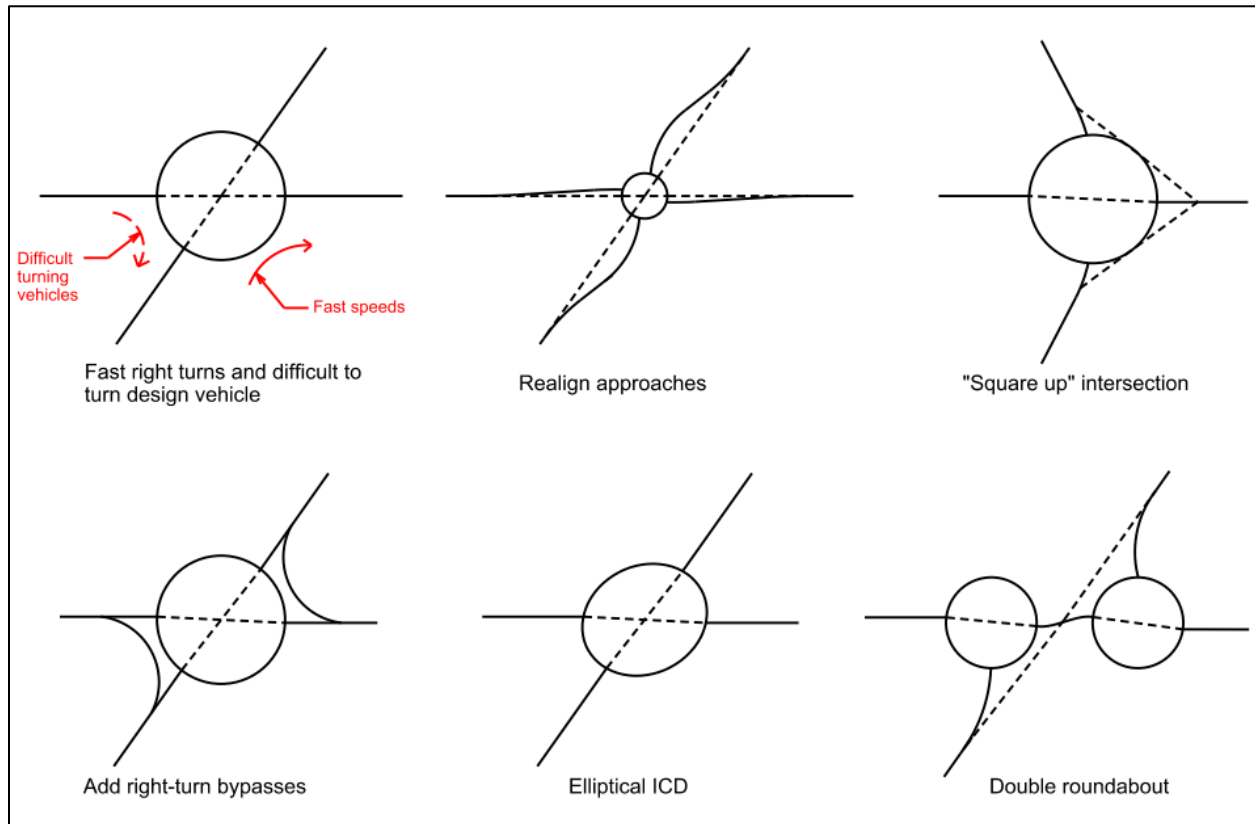


Figure 2-2. Skew Intersections

When two approaches intersect at an acute angle, an ellipse design is practical for separating the approaches to facilitate truck turning and to control entry speeds. The smaller radius of the ellipse should be placed into the quadrant of the acute angle of the two approaches, as shown in Figure 2-2. For single lane conventional roundabouts having a substantial central island, the smaller radius is typically in the range of 120 to 150 ft. with the larger radius being only 20 to 40 feet larger.

It is desirable to arrange the legs of a roundabout to form equal angles between adjacent legs promoting minimum swept paths for large trucks and balancing of the entry path speed reduction for both approaches.

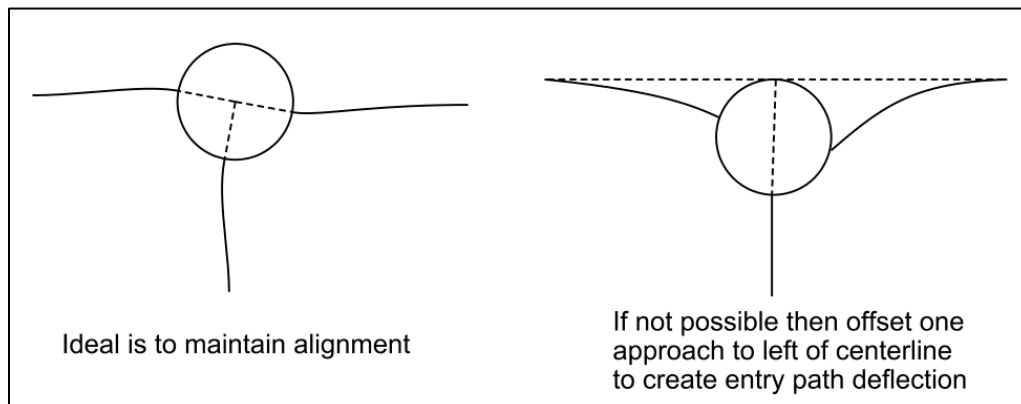


Figure 2-3. T Intersections

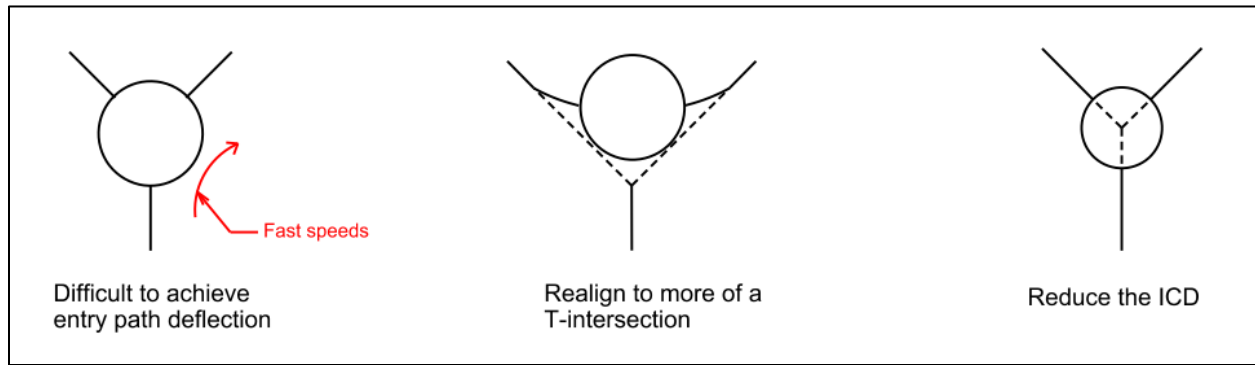


Figure 2-4. Y Intersections

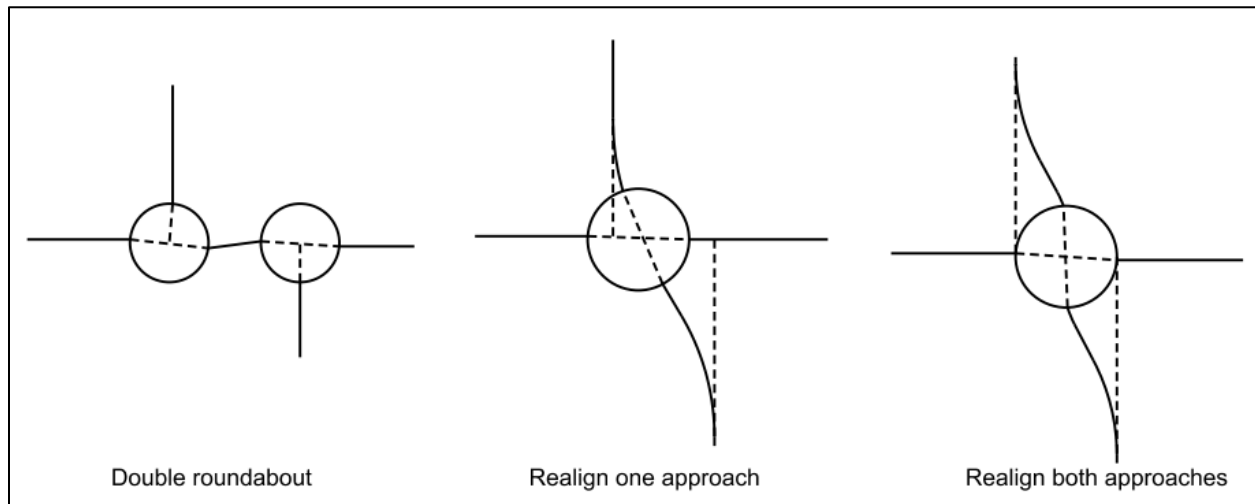


Figure 2-5. Offset Intersections

2.7 DESIGN OF APPROACHES

The primary safety concern, especially with rural approach design, is to make drivers aware of the roundabout with ample distance to gradually decelerate to a slow entry speed of 20 to 25 mph. Approach geometry should build driver expectation to yield at entry, a fundamental operating condition to maintain priority to circulating traffic. Geometric design that is safe and practical generally exhibits these principles:

- Desirable stopping sight distance (forward visibility) of the roundabout entry, based on approach design speed.
- Approaches horizontally and vertically aligned to make the entry and central island conspicuous.
- Approach alignment that is offset left of the circle center (see Figure 2-6) is most beneficial to gradual speed reduction and yield at entry, especially in multilane roundabouts. Offset left approach alignment generates the necessary entry path deflection to achieve geometrically slow entry speeds. For additional information, see NCHRP Report 672, Sections 6.2.1 & 6.7.1.

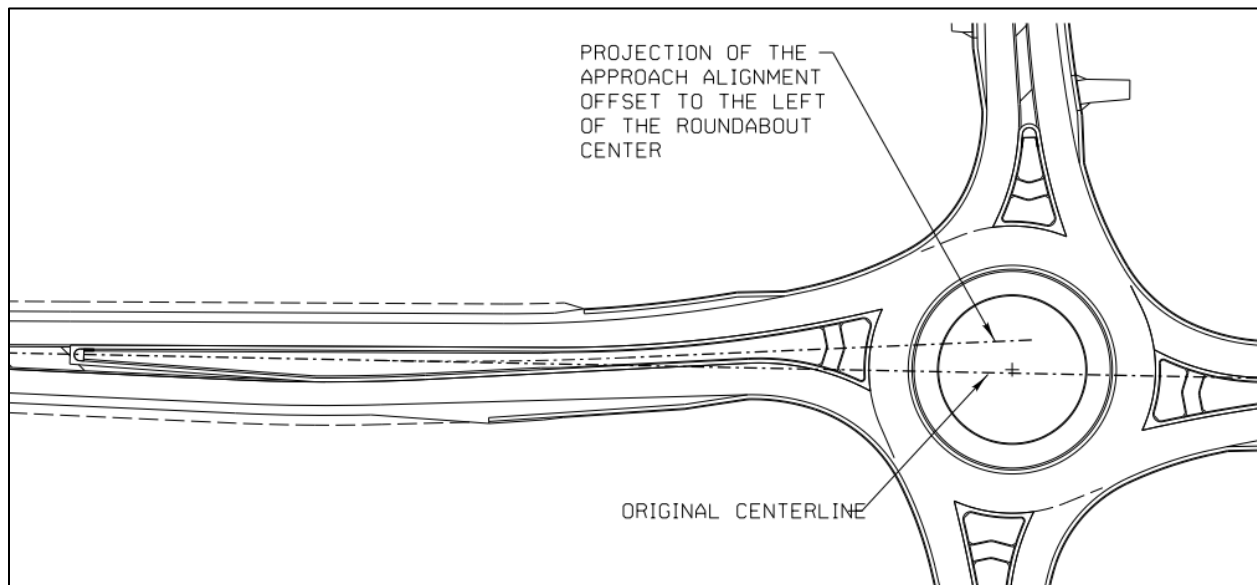


Figure 2-6. Left Offset Design for Entry Deflection

In addition, rural and higher-speed suburban design conditions benefit most from applying these principles to approach alignment (see Figure 2-7):

- Splitter islands that extend upstream of the yield line to the point at which entering drivers are already decelerating - 200 feet or more is desirable for 45 MPH or higher, 100 feet or more is desirable for speeds ranging from 35 mph to 45 mph; and, 50 feet is acceptable for speeds 30 mph and lower.
- The nose of the approach splitter island should have a minimum 3 ft. radius and incorporate a 2 to 4 ft. offset from the face of curb to the paint line on high-speed approaches
- Approach curves that are successively smaller, gradually reduce approach speeds. Selection of approach curve radius that is based on the approach design speed and expected speed change will preclude superelevation (See Figure 2-8). If an approach curvature is used to introduce additional entry path deflection, a radius large enough to maintain normal crown or at most reverse crown is advised.
- Placing a tangent at least the length of the design vehicle between successive reverse curves minimizes swaying of large truck loads and loss of control roadway departure crashes, e.g. motorcycles.
- Preserve forward sight distance (stopping sight) when adding reverse curvature to the splitter island of a high-speed approach. This is necessary both horizontally and vertically.
- Provide a “visibility package” (items like signs, rumble strips, pavement marking and raised pavement markers/delineators) for rural roundabout approaches and in some cases, illumination in transition to the roundabout. This can partially compensate for splitter islands that are shorter than 200-ft.
- Introduce curbed roadway in the transitional and low speed segments of the approach. Graduation from paved shoulder to mountable curb to vertical face curb provides an ideal transition from rural to urban cross-section.

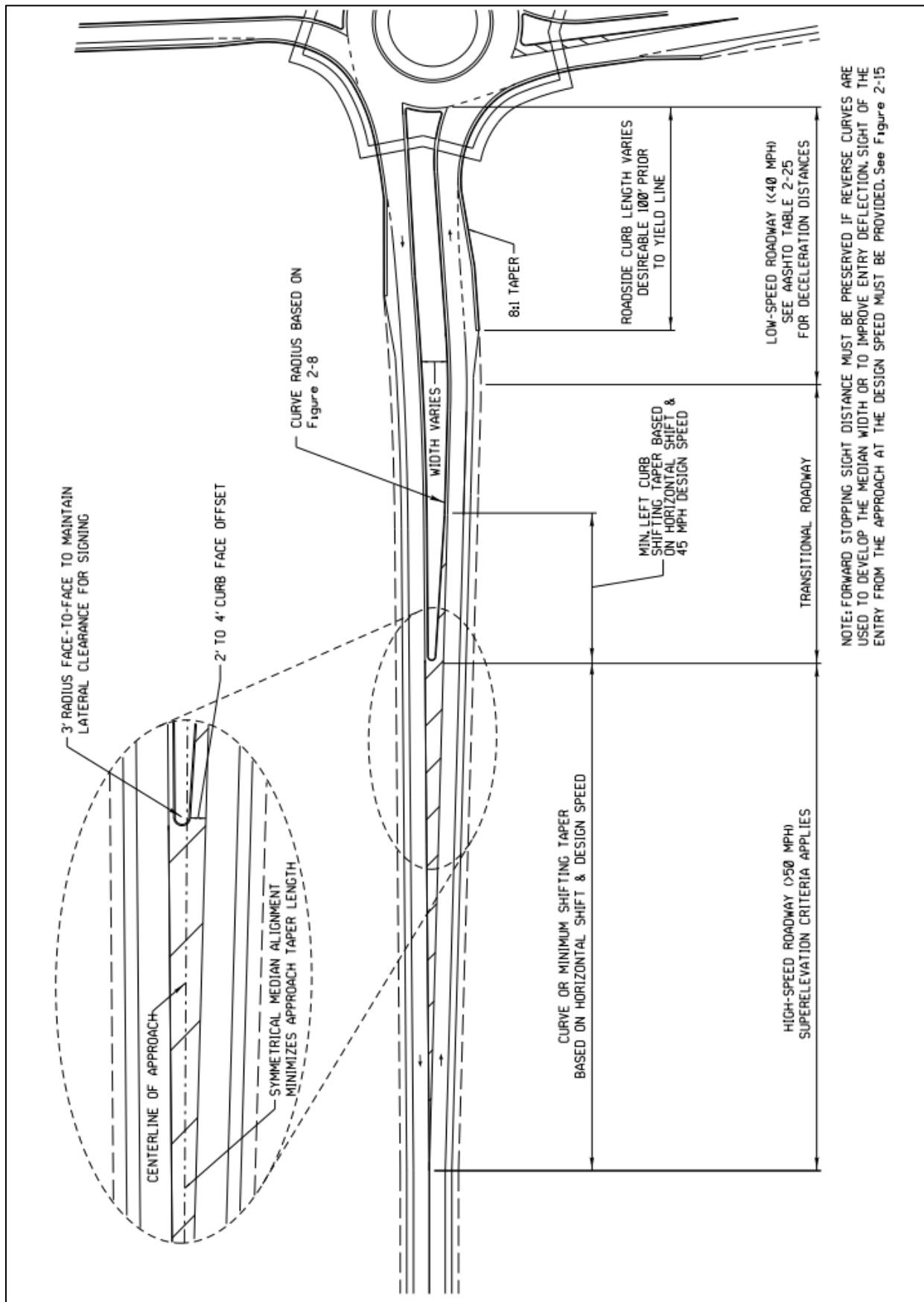


Figure 2-7. High-speed Approach Splitter Island Design

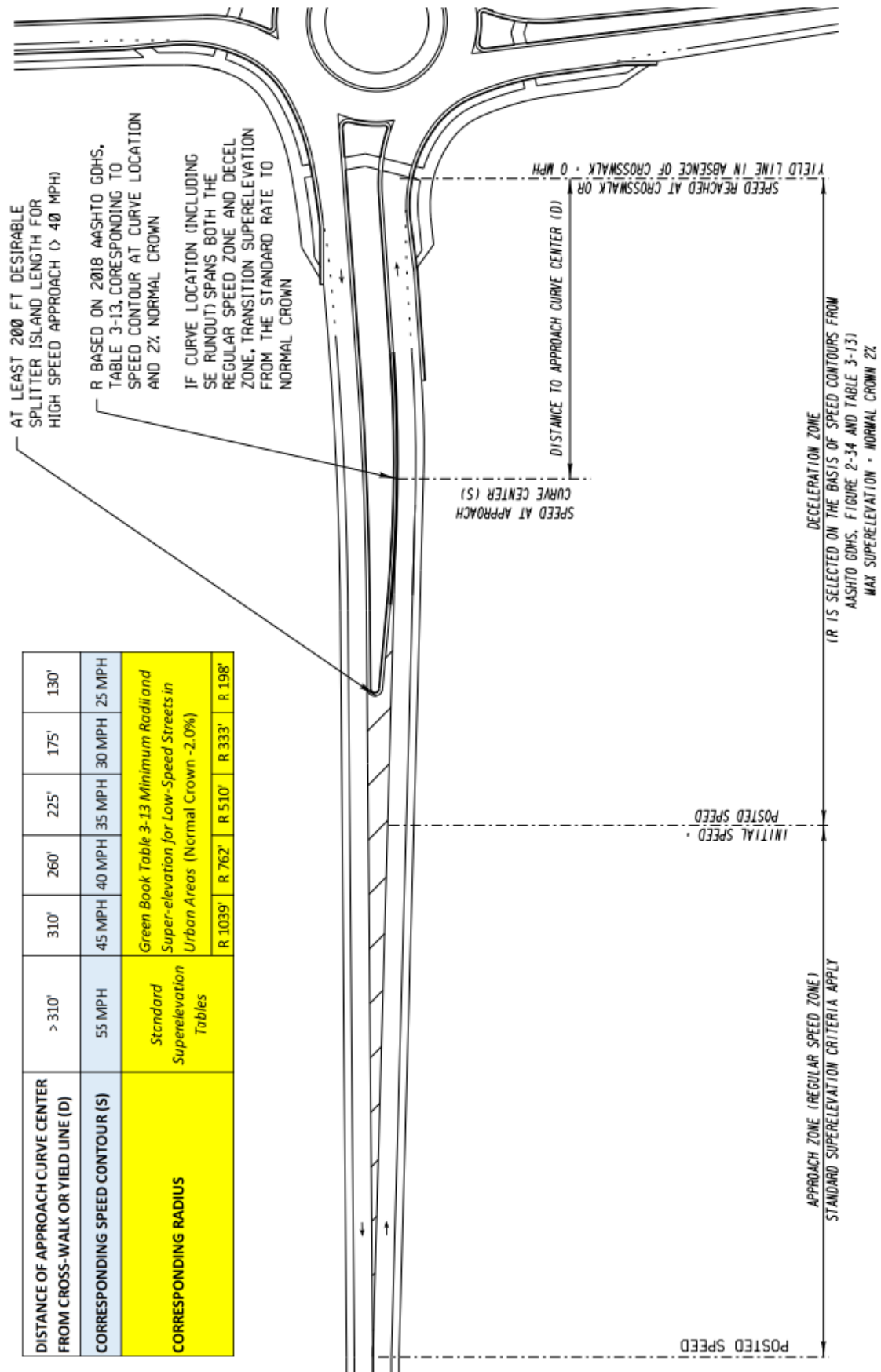


Figure 2-8. Superelevation on Approach

2.8 ENTRY CURVES

At roundabout entries, the right side curve near the roundabout entry, sometimes called the controlling radius, should be in the range of 65 to 100-ft. to help control entry speeds. A rule of thumb is to use an entry radius half of the ICD. The left side radius can be larger since it has no effect on speed control but does have an effect on truck swept paths. Running swept path checks to minimize the controlling radius and to minimize entry width may require thinning the splitter island at the entry as shown in Figure 2-9. In this way, the controlling radius can be minimized while accommodating trucks.

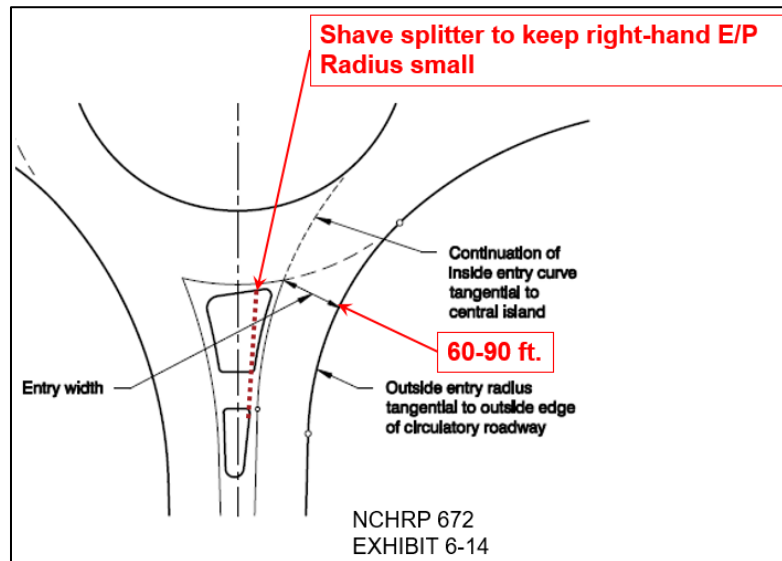


Figure 2-9. Entry Curve

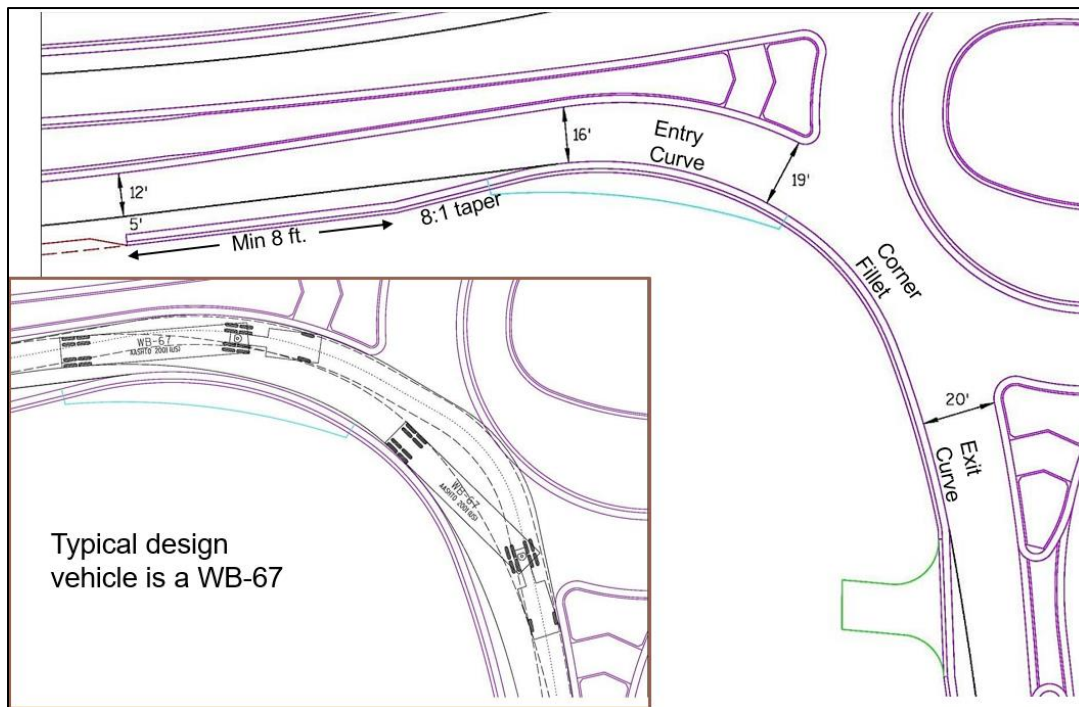


Figure 2-10. Example of Typical Entry to Exit Curves

Figure 2- 10 illustrates a typical layout showing roadway width for approaches and exits. Along with this guidance, the following should be considered:

- Place Curb and gutter on both sides to define the roundabout entry and exit
- Approach width of pavement that accommodate the design vehicle and allow for passing a stalled vehicle at single-lane entries and exits are as follows per AASHTO GDHS 2018 Table 3-27 (Face of curb to face of curb):
 - Design width for entries, exits and right-turn bypass lanes is 20 ft. (desirable) to 24 ft. (maximum) face of curb to face of curb.

2.9 ENTRY PATH DEFLECTION (‘FASTEST PATH’)

The geometric design speed of the entry of the roundabout, often referred to as the “fastest path” of the roundabout, is a critical safety performance measure in the design of roundabouts. It correlates with the probability and severity of crashes between entering and circulating vehicles. The geometric design speed of each movement is determined by drawing the fastest path possible for a passenger car making a through movement, crossing a roundabout. Figure 2-11 to Figure 2-13 illustrate the three major movements through a single-lane, multilane and ‘Y’ roundabout, respectively; and, the five corresponding critical path radii required to be checked for each approach.

Geometric entry path deflection is best represented by continuous a spline (a curve with constantly changing radii) because this most closely approximates how a vehicle traces its fastest path through a roundabout. It is drawn from a starting point approximately 165 ft. in advance of the yield line, with an offset of 5 ft. from curbs, 5 ft. from a centerline; and, 3 ft. from other pavement markings (such as a painted median or two-way left-turn lane). The critical entry path radius, referred to as R1, occurs over the spline for a distance of 65 feet to 80 feet, near to the yield line, where the tightest radius exists on the spline. The center of the curve should be near the crosswalk and upstream of the entry. Vehicle speed estimation is in accordance with NCHRP 672, Section 6.7.1.2 Equations 6-1 and 6-2. Equation 6-3 may be used to estimate actual entry speed, but it does not govern the fast path performance check.

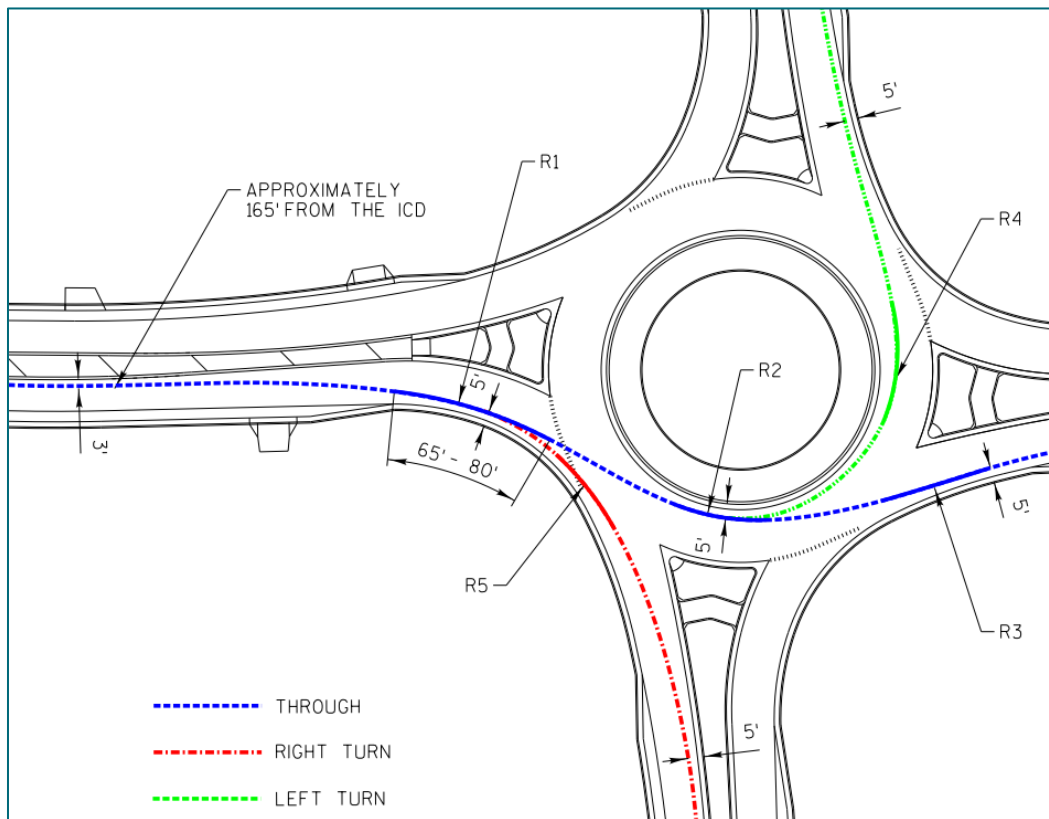


Figure 2-11. Determination of Entry Path Curvature – Single Lane Roundabouts

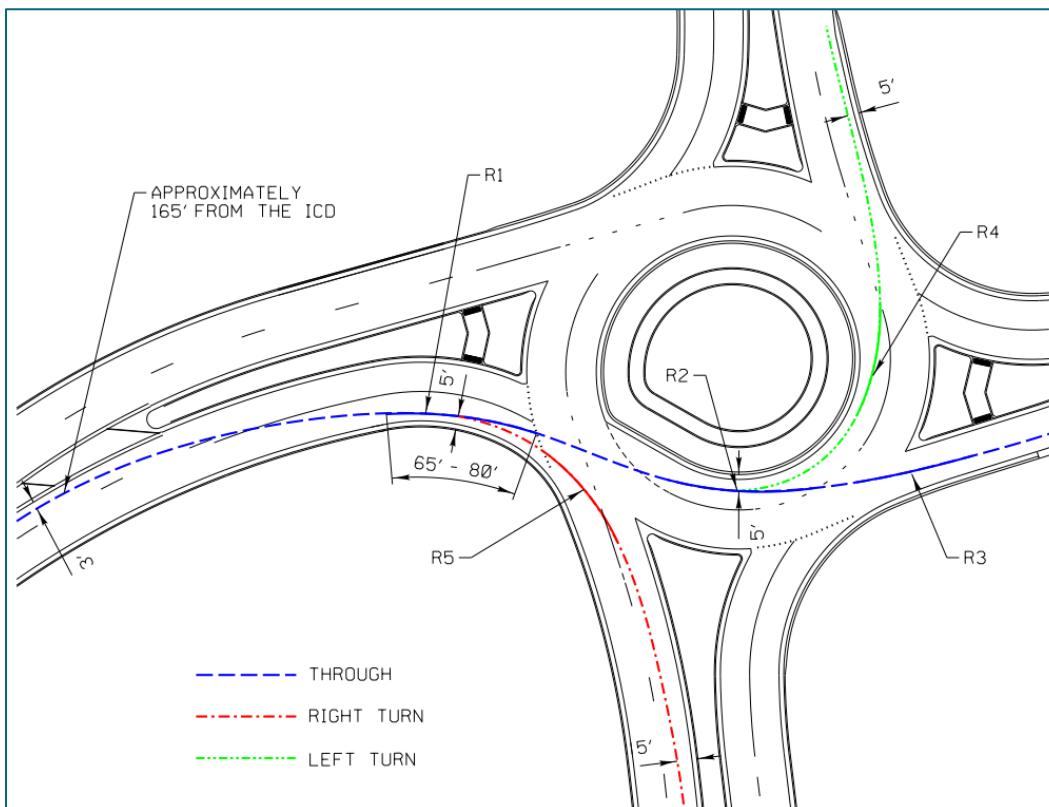


Figure 2-12. Determination of Entry Path Curvature – Multilane Roundabouts

Under urban conditions where pedestrians are present, desirable values of fast path speeds should be in the low range of values shown in the table. Entry radii values correspond with the R1 speeds, 2% cross-slope, and nominal pavement friction values per the AASHTO 'Green Book'.

2.10 STOPPING SIGHT DISTANCE

Horizontal and vertical Stopping Sight Distance (SSD) must be checked for roundabout approaches, using Driver eye height of 3.5 ft. and object height of 2 ft. for:

1. Approach SSD (Figure 2-14 and Figure 2-15)
2. SSD to the downstream crosswalk (Figure 2-16)
3. SSD around the circulatory roadway (Figure 2-17)

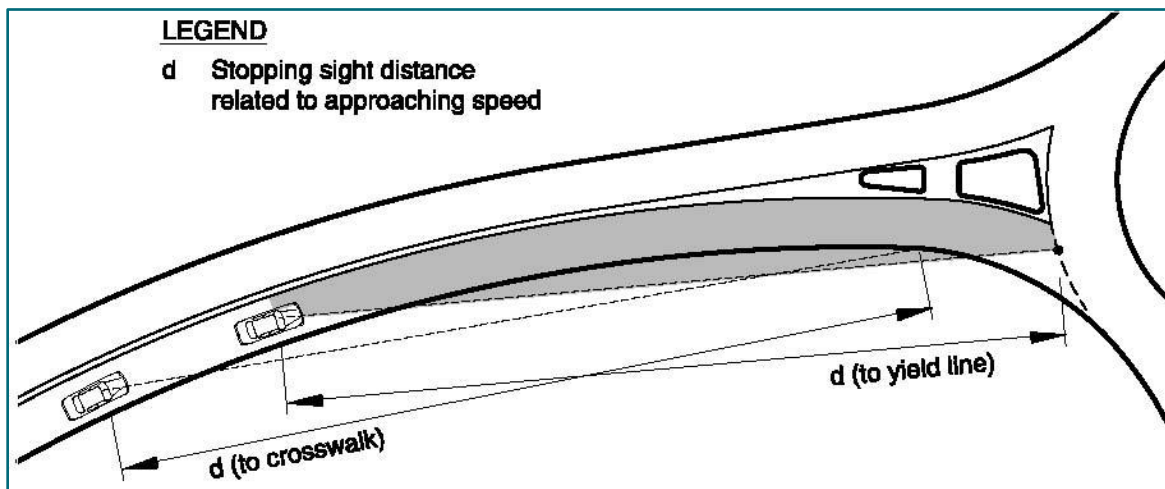


Figure 2-14. Approach Stopping Sight Distance

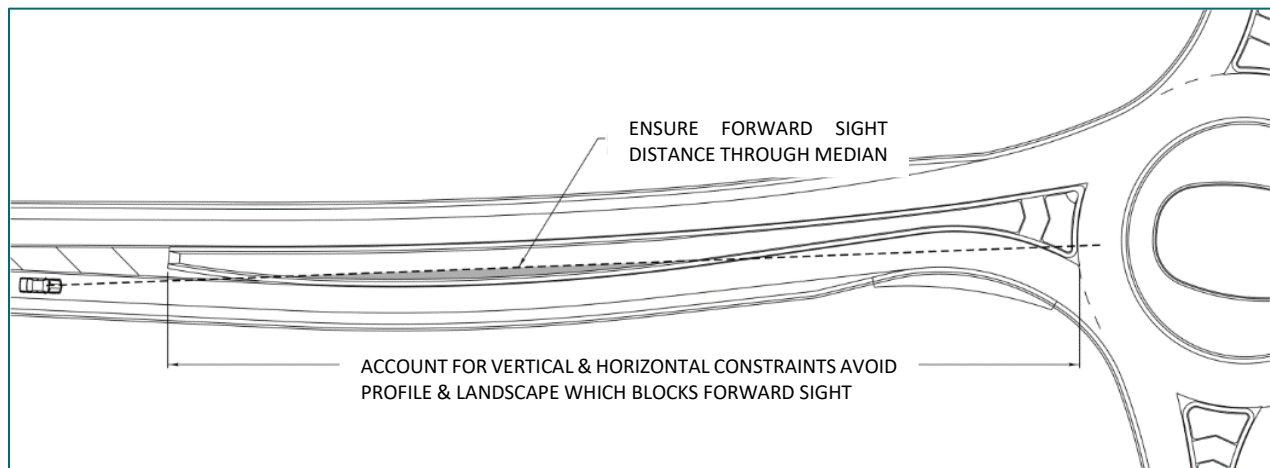


Figure 2-15. Approach Stopping Sight Distance with Reverse Curves

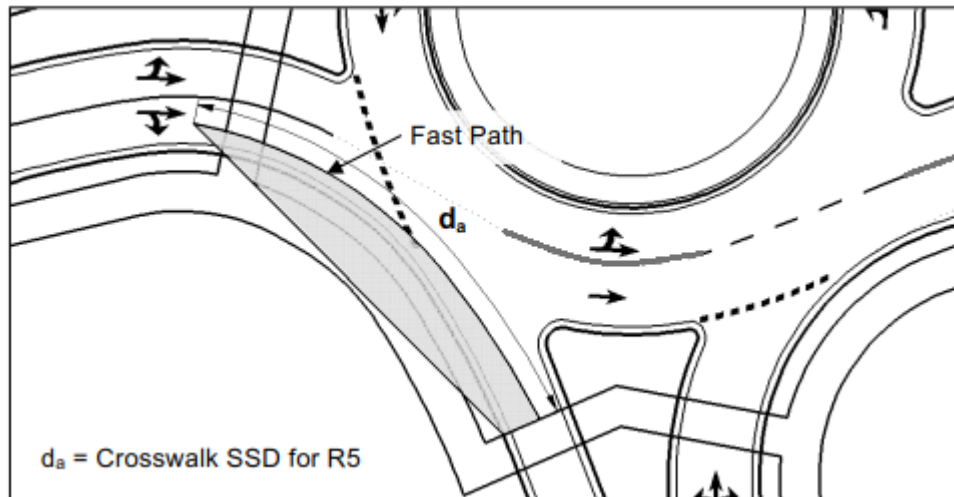


Figure 2-16. Stopping Sight Distance to the Downstream Crosswalk

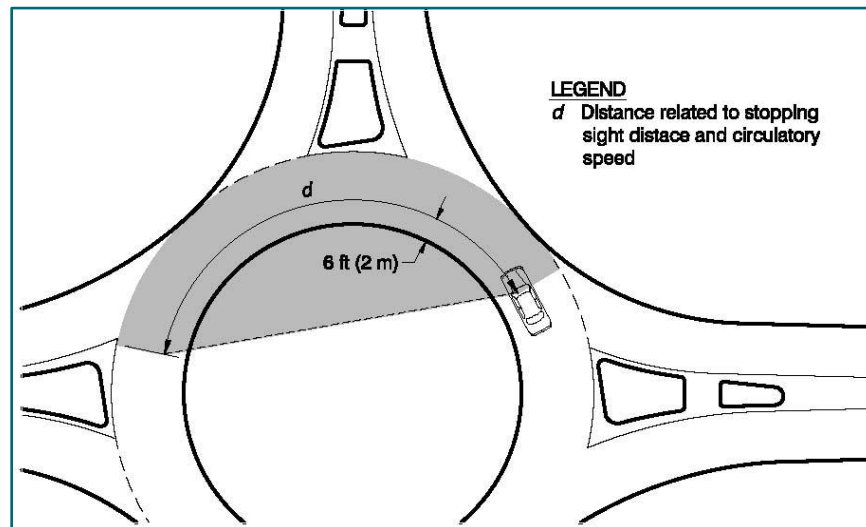


Figure 2-17. Stopping Sight Distance around the Circulatory Roadway

Where there is a desire to create a “table-top” profile at a roundabout entry (e.g. for crosswalk transverse grade of 2% per US Access Board accessibility design criteria), the approach stopping sight may be lost or traded-off and compensated for with additional approach visibility elements, e.g. signs. Figure 2-18 illustrates the vertical sight distance problem created by flattening the approach profile versus a slightly steeper profile. Selection of K values based on the design speed approaching the roundabout does not guarantee approach stopping sight. Tipping the circle or raising the central island height, to improve central island visibility, is a method of combatting the loss of approach stopping sight.

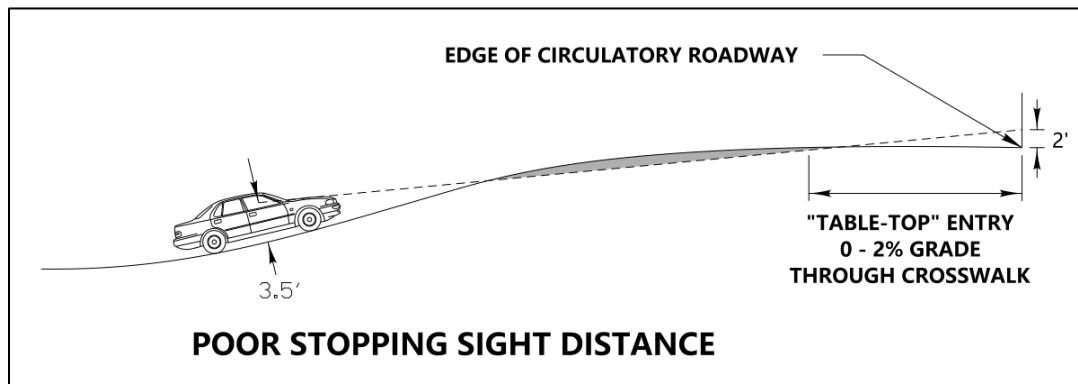


Figure 2-18. Vertical Considerations of Approach Stopping Sight Distance

2.11 INTERSECTION SIGHT DISTANCE

Intersection Sight Distance (ISD) is the distance required for a driver without the right-of-way to view and react to the presence of conflicting vehicles. ISD should be checked at entries for entering and circulating conditions:

- Entering ISD is obtained from the speed of the upstream through movement's fastest path (V1 and V2) as a desirable criterion; or, from 50 feet upstream of both approaches as a minimum criterion; and,
- Circulating ISD is obtained from the speed of the circulating path (V4). See Appendix C for how to determine ISD envelopes.

Figure 2-19 illustrates the range of ISD that uses the upstream fast path sight distance for the speed (standard) and the minimum ISD that uses 50 feet from the edge of the circulatory roadway. The minimum applies where there are site constraints, e.g. guardrail or bridge walls near a roundabout approach. More than adequate sight distance is undesirable because it can lead to drivers competing for gaps and failure to yield conflicts.

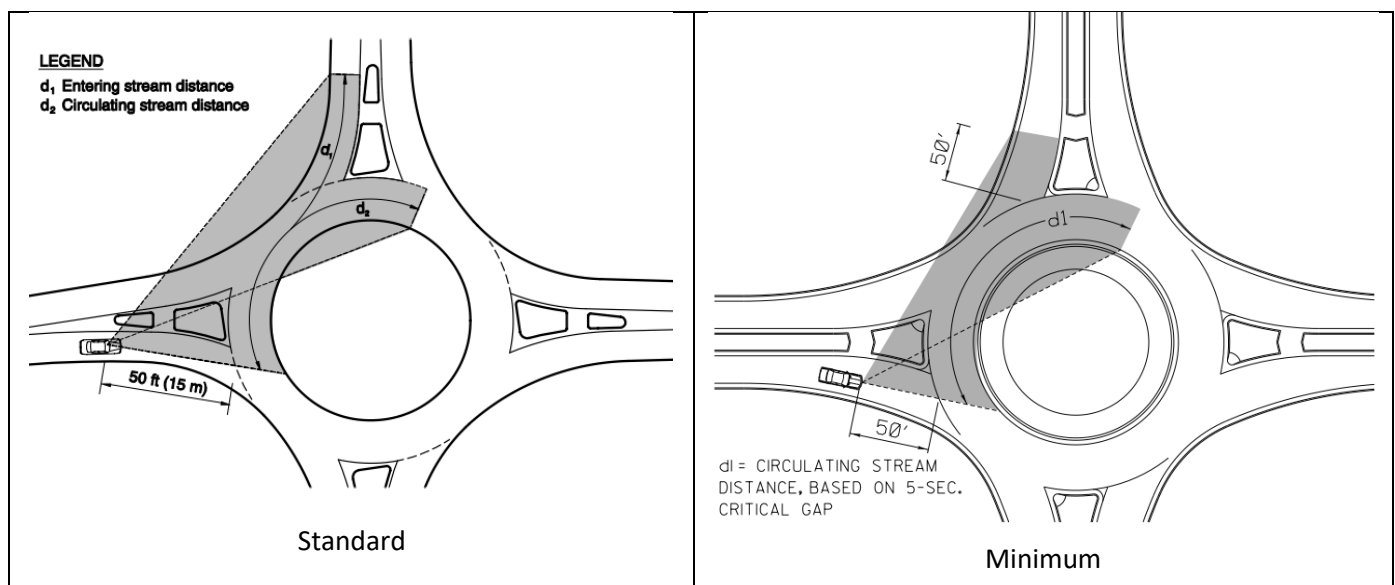


Figure 2-19. Standard and Minimum Intersection Sight Distance

2.12 TRUCK CONSIDERATIONS

Roundabouts are designed with a mountable and raised truck apron where the design vehicle swept path is expected to off-track beyond the circulatory roadway into the central island. The design vehicle should not over-track onto outside curbs or sidewalks. Accommodation of the design vehicle is verified through horizontal swept path analysis and, sometimes, vertical clearance analysis (See Appendix C on how to perform AutoTURN analysis of truck swept paths).

The truck apron width may vary based upon the circle size and geometric composition of the roundabout. The truck apron should be wide enough to accommodate the swept path of the off-tracking trailer plus one foot.

At multilane roundabouts where truck traffic volume is high side-by-side traffic may result and pose a challenge to tracking within lanes. Three cases for truck tracking consideration are identified as follows:

- Case 1 – Truck does not stay in-lane on entry or circulating
- Case 2 – Truck stays in-lane on entry, but not circulating
 - Case 2B – Truck stays in-lane on entry; and, leaves sufficient residual space for a passenger car (approximately 8ft. to 10ft.) to circulate next to the truck
- Case 3 – Trucks in-lane on both entry and circulating

The threshold of need to consider using Case 2 design for trucks is approximately 120 trucks per hour per approach (2 per minute). Below this threshold, it is reasonable to use a Case 1 design, particularly in an urban context where smaller circles and lower entry speeds are desirable for pedestrian safety. Case 2 or 2B should be used where the percent of trucks is higher such as at roundabouts at interchanges.

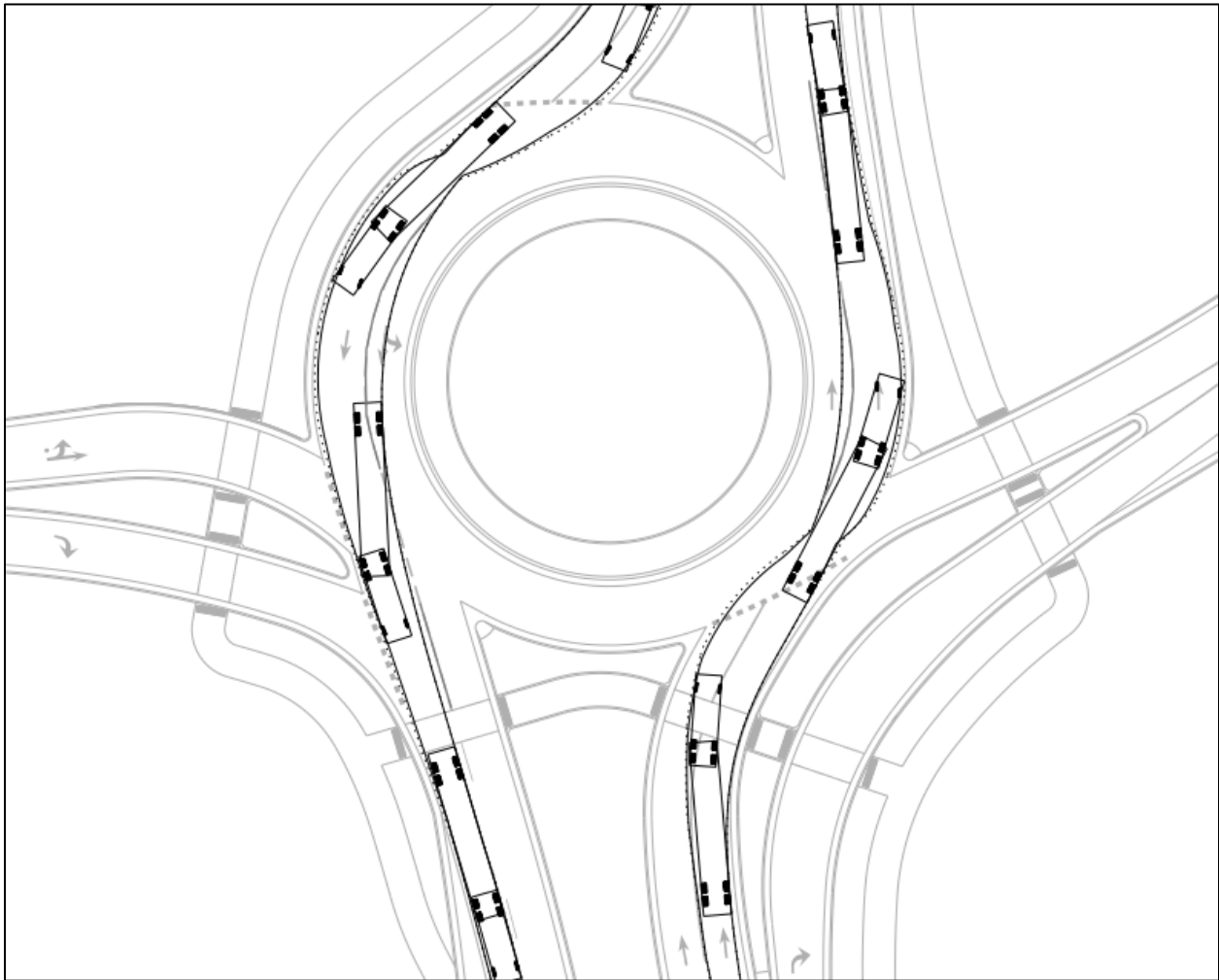


Figure 2-20. Case 1 – Truck does not stay in-lane

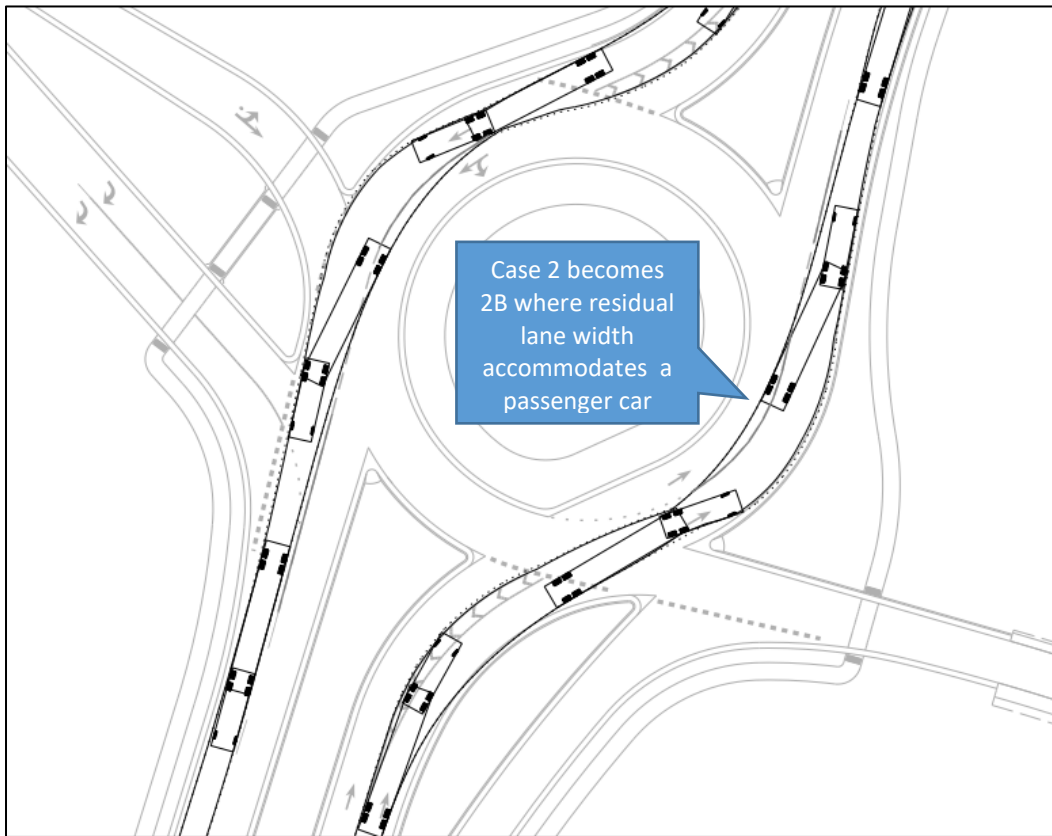


Figure 2-21. Case 2 – Truck stays in-lane on Entry, *not* Circulating

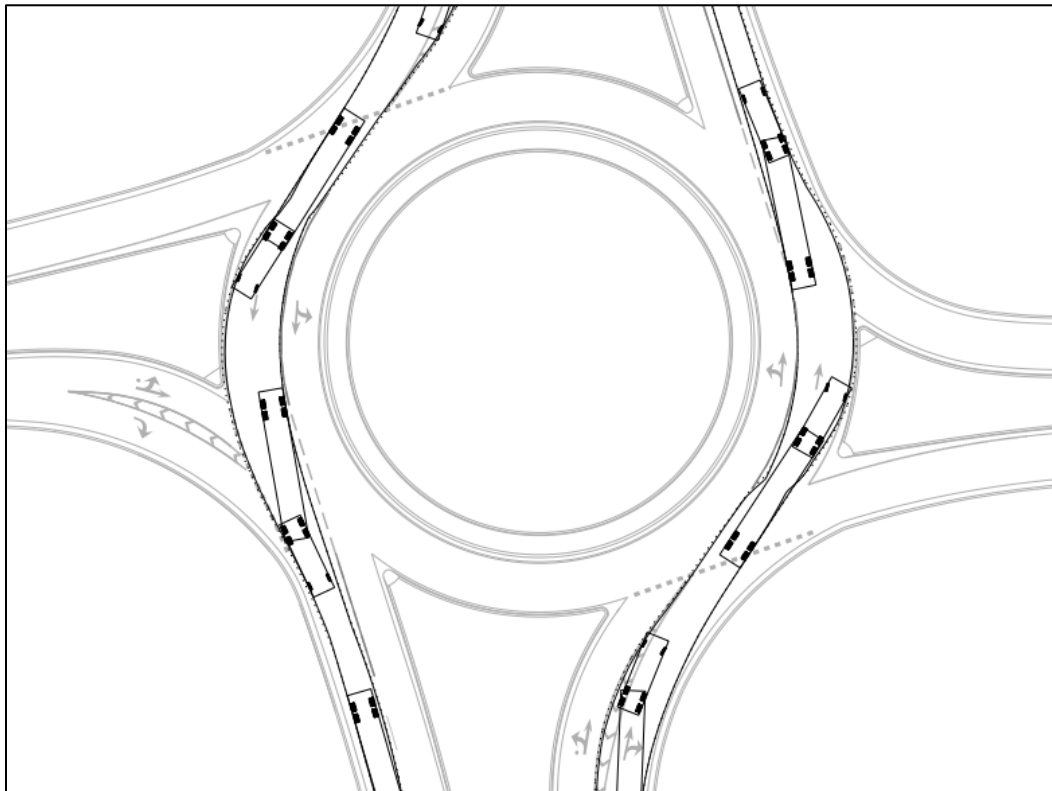


Figure 2-22. Case 3 – Truck stays in-lane on Entry *and* Circulating

Additionally, all roundabouts, except mini-roundabouts, should be designed to accommodate buses and emergency vehicles within the travel way without over-tracking onto the truck apron. When conducting a swept path analysis for the design vehicle, provide 1-ft. minimum clearance from the tire to the curb face. The trailer of the truck may require the use of a truck apron around the central island; however, the tractor should not need to use the apron to navigate the roundabout unless it is compact or a mini-roundabout.

Over-tracking pads (external truck aprons or truck blisters) may be necessary behind outside curb radii at skewed intersections or on compact roundabouts to accommodate the larger design vehicles. However, avoid placing the over-tracking pads through crosswalks, especially in areas with high pedestrian traffic. The safety and accessibility of the pedestrian waiting to cross the intersection can be jeopardized when trucks frequently mount the outside curb and over-track the crosswalk landing.

2.13 CHECK VEHICLE OVERSIZE/OVERWEIGHT (OSOW)

Unlike the design vehicle, a check vehicle is a non-standard vehicle that may utilize the intersection or corridor on multiple occasions, but not necessarily on a constant/regular basis. These are oversize trucks that travel on the highway network on a permit basis. These vehicles typically transport oversized or overweight loads, which need special accommodations and/or escorts. OSOW status is given to vehicles when they are over-length (100 ft.), overweight (80,000 lb.), over-width (102 in.), over-height (13.5 ft.), or any combination of these. Once a roundabout is programmed to be constructed, OSOW single-trip permits should be requested to determine and analyze the check vehicle on the roundabout design. Further discussion on review of OSOW permits, fleet and analysis are included in Appendix D.

2.14 MULTILANE ROUNDABOUT ENTRY PATH ALIGNMENT

For multilane roundabout entry design, it is necessary to align the entry paths of side-by-side passenger cars. This reduces the risk of sideswipe collisions and operational turbulence at entries and exits. Path alignment problems occur when the natural paths of vehicles in adjacent lanes overlap or cross one another. It occurs most commonly at entries where the geometry of the right-hand entry lane tends to lead vehicles into the left-hand circulatory lane. However, vehicle path overlap can also occur at exits, where the exit geometry or striping of exit tends to lead vehicles from the left-hand lane into the right-hand exit lane. Figure 2-23 illustrates an example of entry path overlap at a multi-lane roundabout. For additional information, see NCHRP 672, Sections 6.2.3 & 6.5.4.

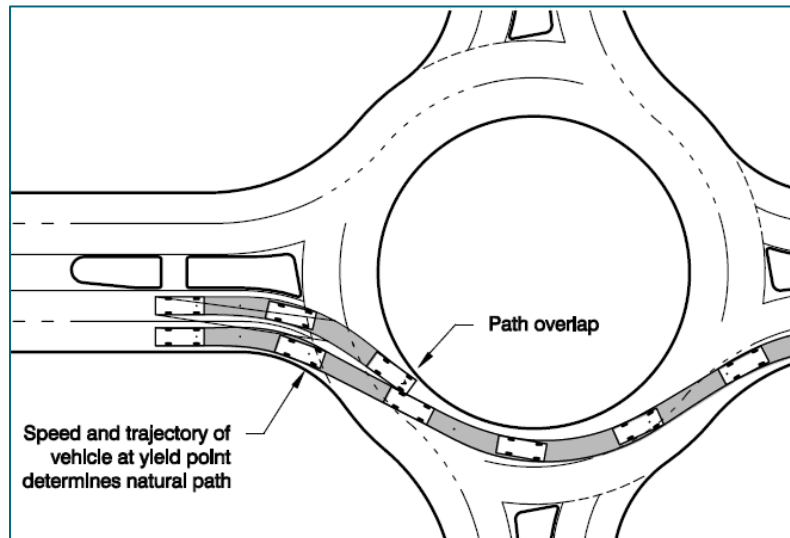


Figure 2-23. Entry Path Overlap

The combination of the approach alignment, entry radius, and location of the entry curve nearest to the yield point directly affects vehicle path alignment. If the speed controlling entry radius is located too close to the circulatory roadway, it can result in path overlap. However, if it is located too far away from the circulatory roadway, it can result in drivers accelerating into the entry before reaching it. For additional information, see NCHRP 672, Section 6.4.3. Figure 2-24 illustrates geometrically efficient characteristics that are both smooth and slow. This minimizes entry and exit turbulence so that multilane designs perform as expected.

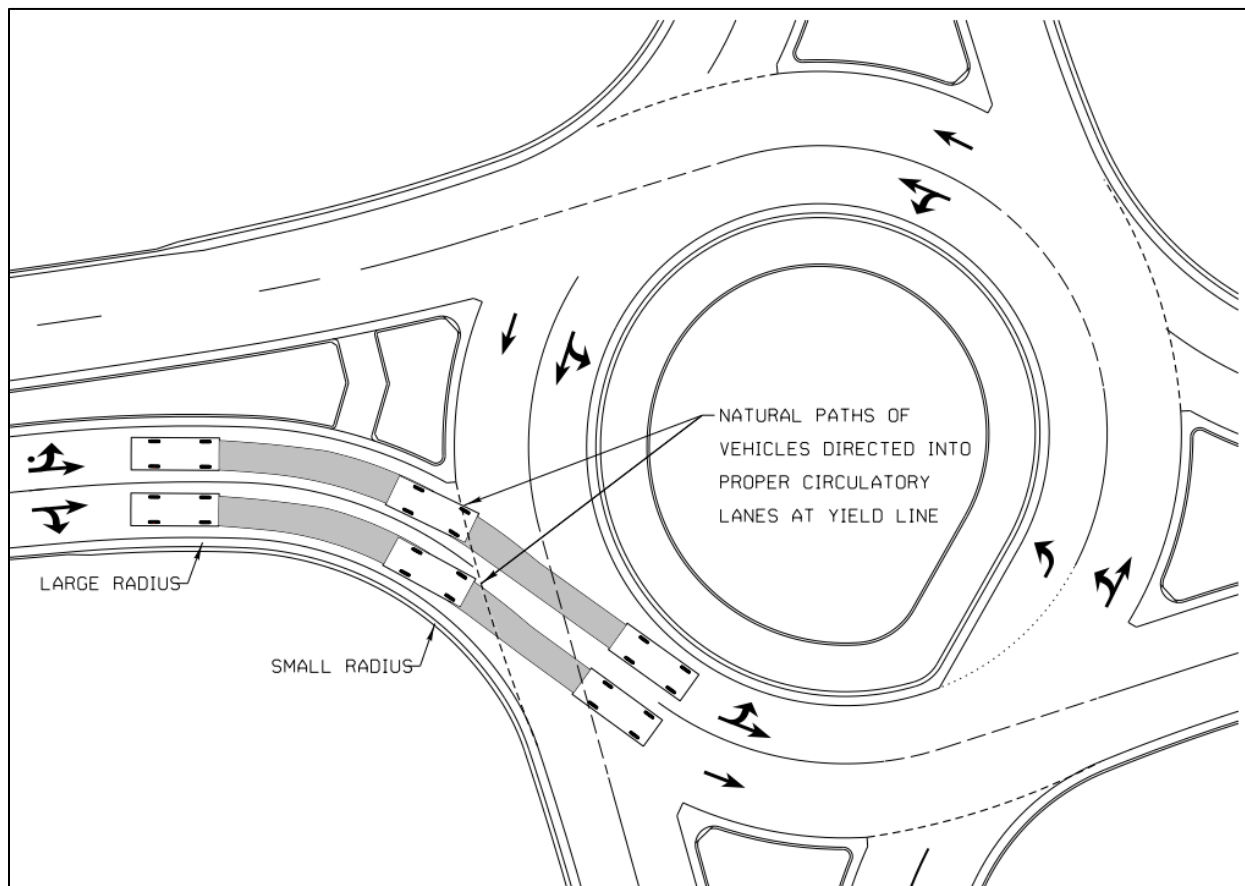


Figure 2-24. Multilane Entry Design to Minimize Path Overlap

Figure 2-25 provides a method for checking entry and exit path overlap. To avoid path overlap, the desirable tangent length should extend from the circulating curve to the entry or exit for the entry path tangent and exit path tangent. As a rule of thumb, path overlap can be avoided if there is approximately 5 feet between the face of the central island curb and the extension of the face of curb on the splitter island with the radius of that curve face extension in the range of 100 ft.

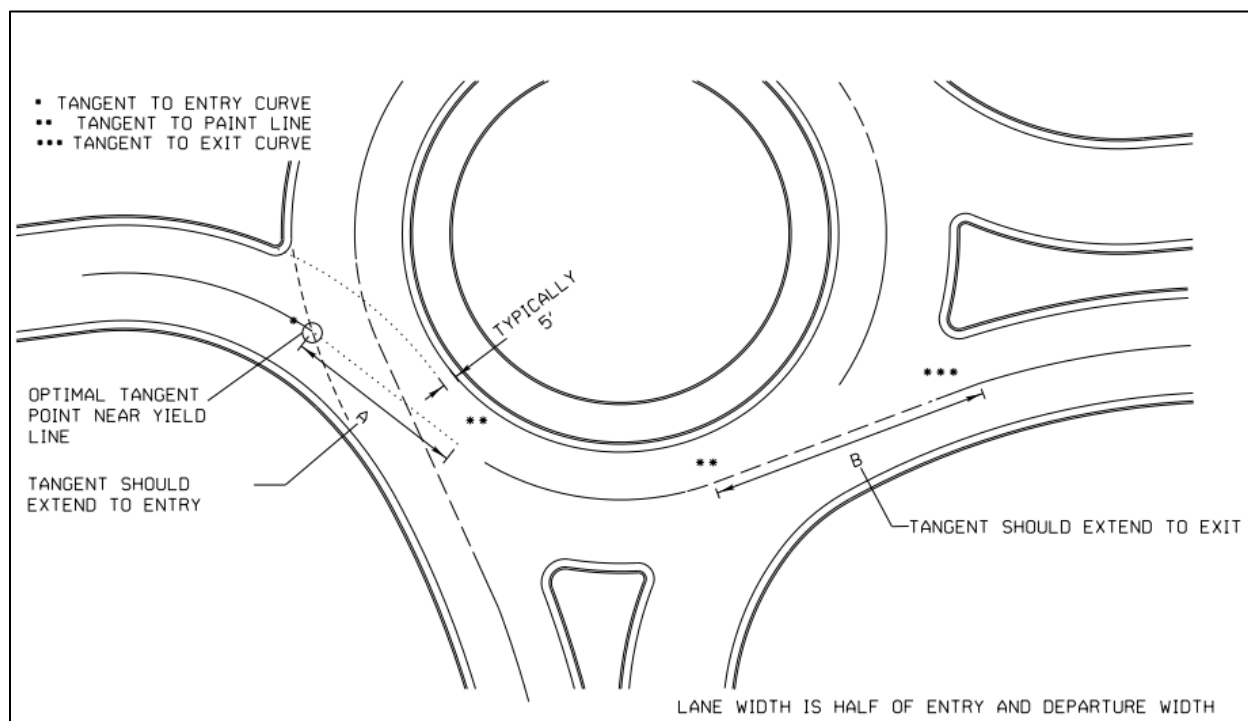


Figure 2-25. Method for Checking Path Overlap

2.15 VERTICAL DESIGN (PROFILES, DRAINAGE AND GRADING)

After the horizontal design of the roundabout is complete, having met all of the geometric design performance checks, horizontal alignments can be set and vertical design can begin. Vertical design components of a roundabout include alignment and profiles, superelevation, approach grades and drainage. The fast-path speed checks should be confirmed after the draft vertical design is complete to determine whether the cross-slopes have an effect on geometric entry speed prediction.

Vertical design is also an iterative process. A simplified process of vertical design is discussed herein; a more detailed process is discussed in Appendix E.

As a best practice, horizontal alignments should be created along the splitter island curb lines of each approach and the truck apron of the central island. It is also recommended to create alignments along the outside curb lines to help to control grades around the circulatory roadway.

Create vertical profiles for the splitter island and circulatory alignments. For the splitter island profiles, choose appropriate K values based on the approach speeds and deceleration speed profiles for roundabout approaches. Minimize construction cost by staying close to the existing surface and matching what the existing roadway is doing at the tie-ins. If low points are required, identify where they are located in relation to the crosswalks. Keep low points out of crosswalks to avoid grate inlets or standing water within crossing areas. Additionally, check that the profile through the crosswalk is no steeper than 2% per ADA requirements.

For the circulatory profile, visualize the roundabout as an upside-down dish tilting on a plane, with one high point and one low point along a continuous profile that closes on itself. Figure 2-29 illustrates a cross-section of a tipped circle. Begin the profile (and therefore horizontal alignment) at a point about halfway between the low point (LP) and the high point (HP), rather than at the LP or HP so that the vertical curves will not be bisected. The circulatory roadway profile will be designed from short vertical curves and tangents and it is recommended to have short curves (K values for 15 to 25 mph), especially near the sag, without flat grades for drainage purposes.

Outside curb line alignments may require profiles to control cross-slopes, particularly in the areas of the entry and exits of the circulatory roadway. Double check that there are smooth transitions and that proper breakovers (< 4%) are maintained.

Generally, the truck apron cross-slope should be kept at a constant cross-slope or 1% to 2% while the circulatory roadway varies according to the 'through' profiles of the intersecting roadways. The cross-slopes for the circulatory roadway should not exceed 4% and should be as smooth as possible while maintaining at least 0.5% profile along outside gutters. The varying cross-slope(s) of the circulatory roadway will determine the tie-in elevations of the splitter island alignments to the outside edge of the circulatory roadway. The cross-slope(s) within the circulatory roadway may need to be adjusted as part of the iterative design process in order to achieve optimal connection between the roundabout and its individual legs.

Once vertical design is complete, a 'design surface' can be created to perform vertical clearance checks for OSOW low-boy trucks, if they were identified as a check vehicle. Appendix D describes how to run a vertical clearance check.

Per Figure 2-26, concrete curb & gutter Type 2 (6 inches high) is used along the outside edge of the roundabout. Header curb or curb & gutter with a Type 9 face (4 inches high) is used on the edge of the truck apron. Curb Type 7 (6 inches high) is used along the landscaped portion of the central island and along the edges of the splitter islands.

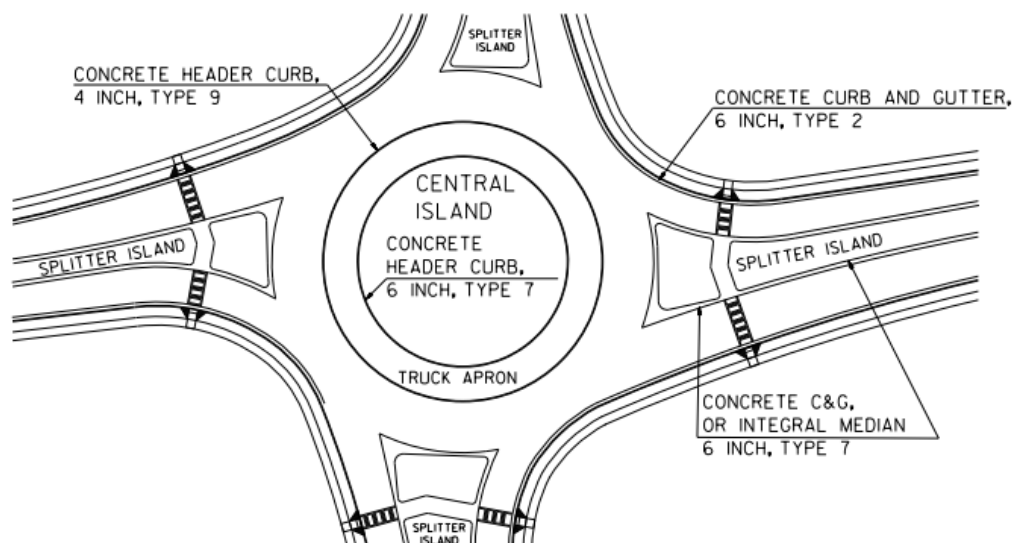


Figure 2-26. Curb types within the Roundabout

2.16 TYPICAL CROSS-SECTIONS

At a minimum, typical sections should be prepared for:

1. Approaches and Exits beyond splitter island areas

2. Splitter Islands
3. Central Island

A simplified typical cross section for a roundabout approach is shown on Figure 2-27. The circulatory roadway should have a cross slope of 1.0% to 2.0%, (see Figure 2-28) preferably outward so that drainage structures may be placed on the outer curbs instead of at the truck apron where trucks will be tracking over. The circulatory roadway can also be viewed as a “plate” which can tilted in one direction so that water will drain to one quadrant (see Figure 2-29A and 2-29B). Figure 2-31 also shows a typical section of a truck overtracking pad (truck blister).

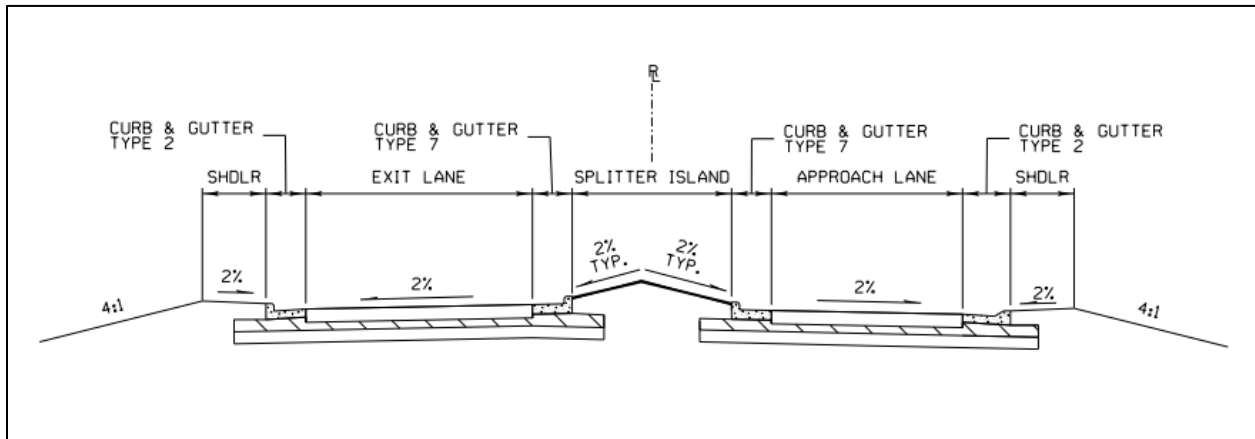


Figure 2-27. Roundabout Approach Typical Cross-section

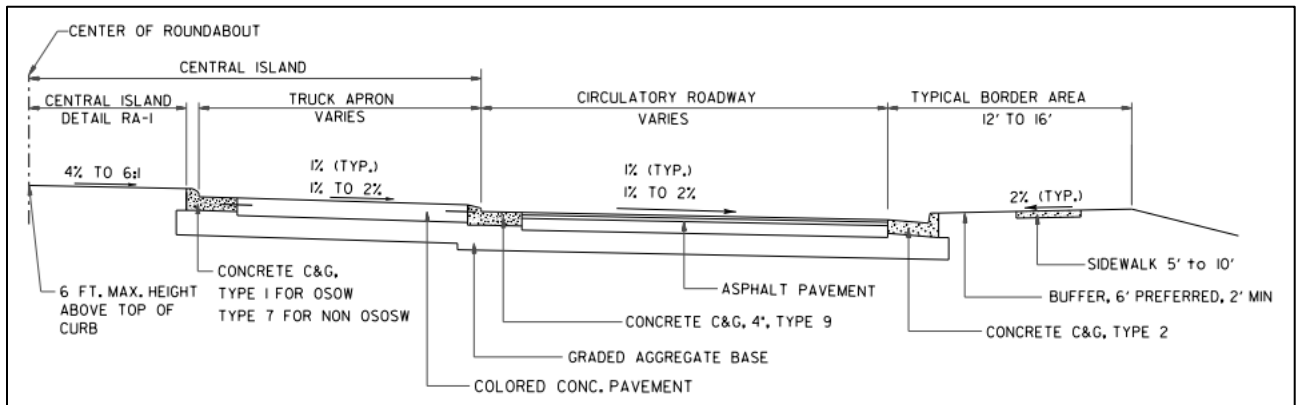


Figure 2-28. Roundabout Detailed Cross-section

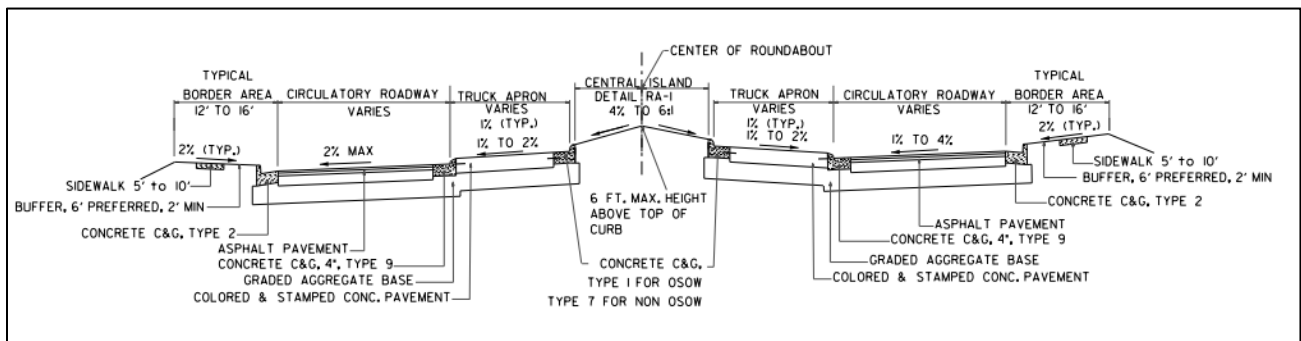


Figure 2-29A. Roundabout with Tipped Circle Cross-section (Truck Apron sloped out)

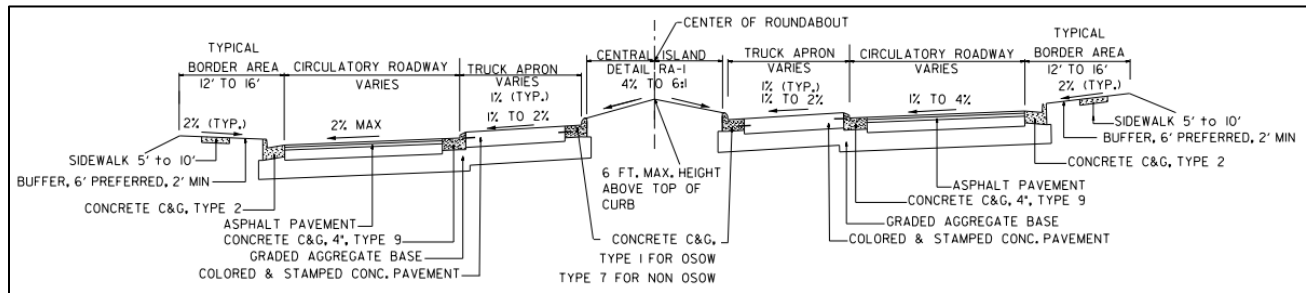


Figure 2-30B. Roundabout with Tipped Circle Cross-section (Truck apron sloped in)

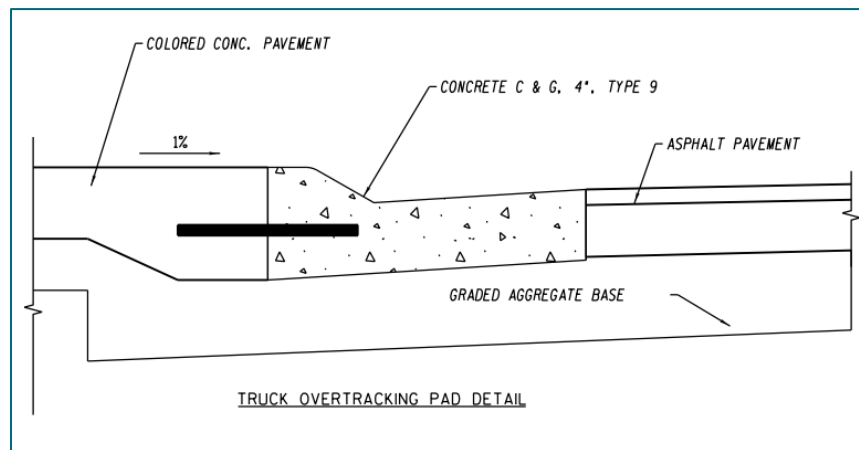


Figure 2-31. Truck Overtracking Pad Cross Section

2.17 MINI ROUNDABOUTS

Generally, mini roundabouts are used by GDOT on low speed roadways (<35mph) or as temporary or quick response project solutions on roadways with a posted speed limit greater than 35 mph. See Appendix B.4 for examples of quick response roundabout plans. Due to the smaller circle size, mini roundabouts have design elements that are slightly different from conventional roundabouts, discussed below.

Because mini roundabouts have less separation between the entries, they should not be used at intersections with five or more legs where adequate deflection may be difficult to achieve. Also, use at intersections with high truck volume (>5%) and where pedestrian traffic is frequent is discouraged.

MOUNTABLE CENTRAL ISLAND

For a mini roundabout to operate as intended, especially on a higher speed roadway, it is essential that the intersection type can be recognized and that drivers have adequate forward visibility of the intersection. For this reason, the central island at mini roundabouts should not be defined by only paint, but slightly raised as a dome, no more than 5 inches, so that it can be driven over by larger vehicles that are physically incapable of maneuvering around it, while discouraging smaller vehicles from driving over it. The apron may have a 3" or 4" mountable curb face or it may be constructed with a "pancake" (flush) lip that is domed in the center. Illuminated bollards with keep-right chevrons are recommended for illumination and visibility of the mini roundabout. These are designed to withstand vehicle overtracking and therefore may be installed on the mountable central island. See Figure 2-32 and Figure 2-33 below.

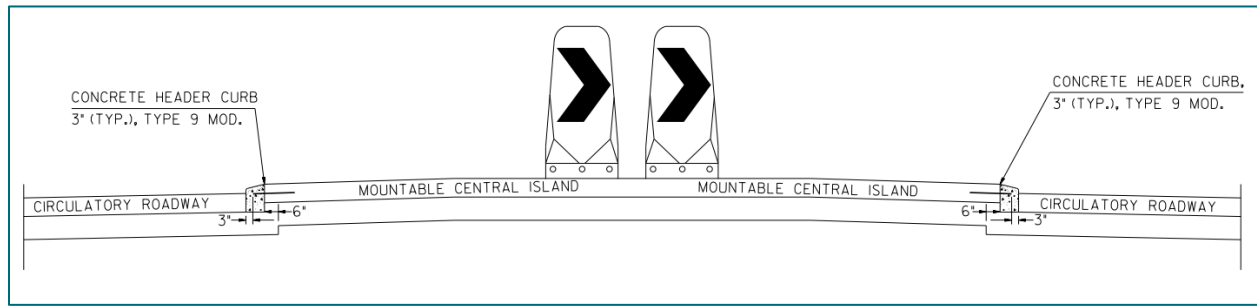


Figure 2-32. Mountable Apron at Mini Roundabouts, shown with Bollards

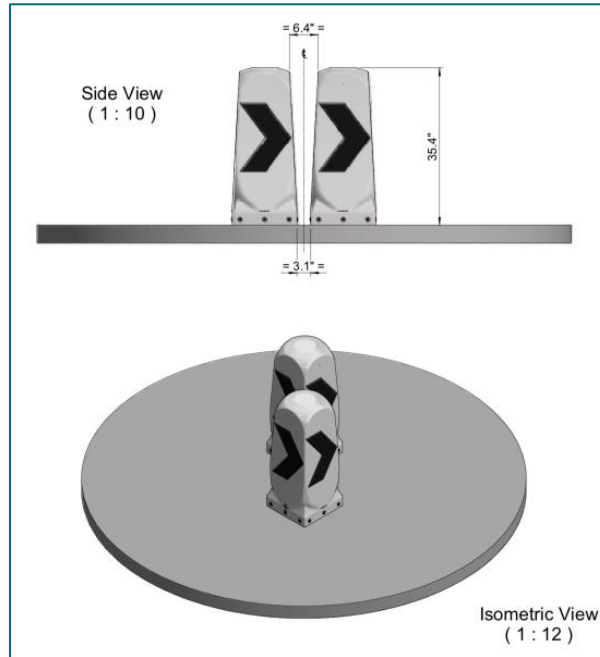


Figure 2-33. Bollard Configuration

DEFLECTION AND SPEED CONTROL

Due to the smaller circle size, geometric entry path deflection at mini roundabouts is not governed by the central island but rather by the approach curvature. Where deflection is desired, especially at more permanent solutions, it is achieved through approach curvature (chicanes) and longer splitter islands (Figure 2 33). These features contribute to recognition of the roundabout ahead so that drivers may decelerate in time.

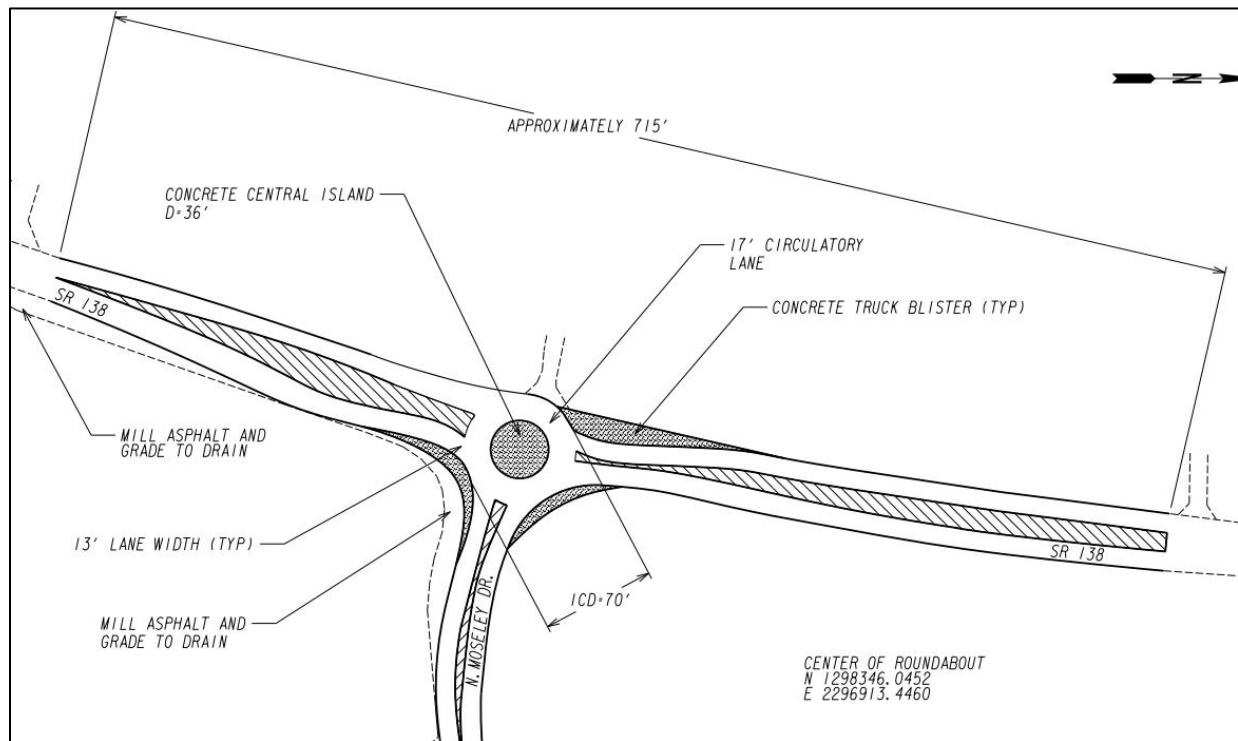


Figure 2-34. Mini roundabout approach deflection

DESIGN VEHICLE

As with conventional roundabouts, a mini roundabout shall be designed to accommodate the design vehicle for the roadway classification. Smaller vehicles should be able to navigate the roundabout without mounting the central island while larger trucks are expected to track over it.

CHAPTER 3 – DESIGNING FOR PEDESTRIANS AND BICYCLISTS

The March 2010 U.S. Department of Transportation (USDOT) Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations states that, the USDOT “is to incorporate safe and convenient walking and bicycling facilities into transportation projects.” Projects should be evaluated to comply with GDOT’s Complete Streets Policy, (Chapter 9 of the Design Policy Manual) which establishes standard warrants and guidelines for the design of features to serve pedestrians, bicyclists, and transit.

3.1 PEDESTRIAN ACCESSIBILITY DESIGN CONSIDERATIONS

Pedestrian crossings at roundabouts must comply with the Americans with Disabilities Act (ADA) accessibility standards. See also National Cooperative Highway Research Program (NCHRP) Report 672, Chapter 5, Section 5.3.3 Pedestrians and NCHRP Report 834, *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook*.

General design elements for pedestrian crossings include:

1. Pedestrian crossing distance and location;
2. Crossing alignment;
3. Splitter island and pedestrian refuge design;
4. Providing for visually impaired pedestrians as well as other disabilities;
5. Discouraging pedestrian from crossing to the central island

In general, pedestrian crossings are placed approximately one car length (20-25 ft.) upstream from the yield point for single-lane entries, and one to two car lengths from the yield point for multi-lane entries (see Figure 3-2 and Figure 3-3). These distances help to reduce decision-making problems for drivers and are close to the circulatory roadway where vehicular speeds are slower. Detectable warnings must be applied at curb ramps and island cut-through, which should be elevated as detailed in GDOT Details A-3 and A-4.

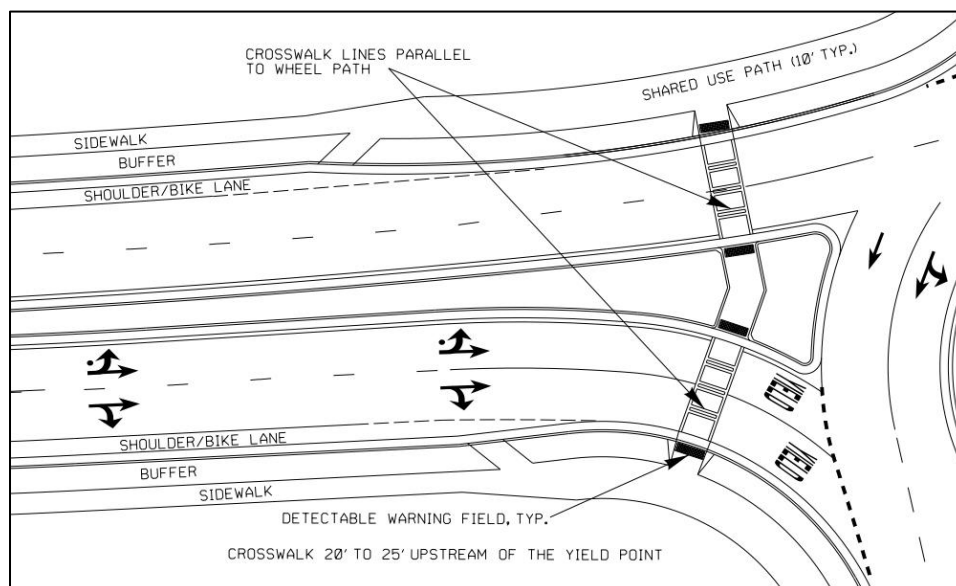


Figure 3-1. Pedestrian Crossing Treatment

There are three general principles for developing design solutions to optimize wayfinding information for visually impaired people who rely on nonvisual information:

1. Landscaping, fences, or other features should restrict the ability of pedestrians to cross at locations other than crosswalks, or at least make it very clear where crossing is not intended, and provide guidance to the crosswalk location.
2. Curb ramps should be oriented so that the running slope is in the same direction as the crosswalk and/or the edges of landscaping or ramps should be aligned in the direction of travel on the crosswalk.
3. Alignment of crossing perpendicular to the edge of the travel way and with direction change on refuge islands creates the shortest crossing paths.

3.2 BICYCLE PROVISIONS

Bicyclists are often less visible and therefore more vulnerable when traveling through roundabouts. For single-lane roundabouts, motorized vehicle speeds are lower, and thus it is not usually necessary to provide a shared-use path around a single-lane roundabout. However, the challenges for cyclists increase at multilane roundabouts due to higher vehicular speeds and the need to use the correct lane when traveling through the roundabout. Shared-use paths (8 ft. min., 10 ft. typ.) and bike ramps shall be provided at multilane roundabouts (and optional at single-lane roundabouts) to provide cyclists with this option. Do not provide a perpendicular ramp between the two surfaces causing bicyclists to stop or nearly stop the forward motion to enter one facility or the other. Place bicycle ramps a minimum of 50 ft. from the edge of the crosswalk. Refer to Figure 3-2 and Figure 3-3 below.

Do not provide a shoulder or bike lane within the circulatory roadway. Begin and end the paved shoulder or bike lane upstream of the yield point to allow the bicyclist an opportunity to transition either onto the regular lane (shared with motorized traffic), or where available, the shared-use path (shared with pedestrians). It is recommended to begin and end paved shoulders or bike lanes using an 8:1 taper rate.

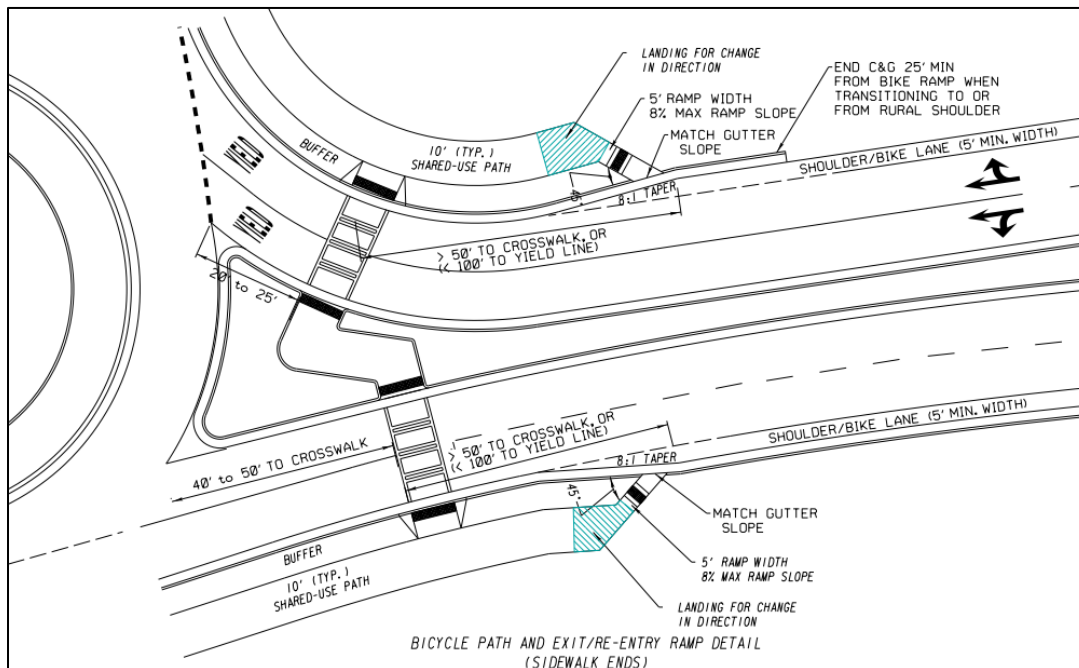


Figure 3-2. Bicycle Path Exit and Entry without Extended Sidewalk

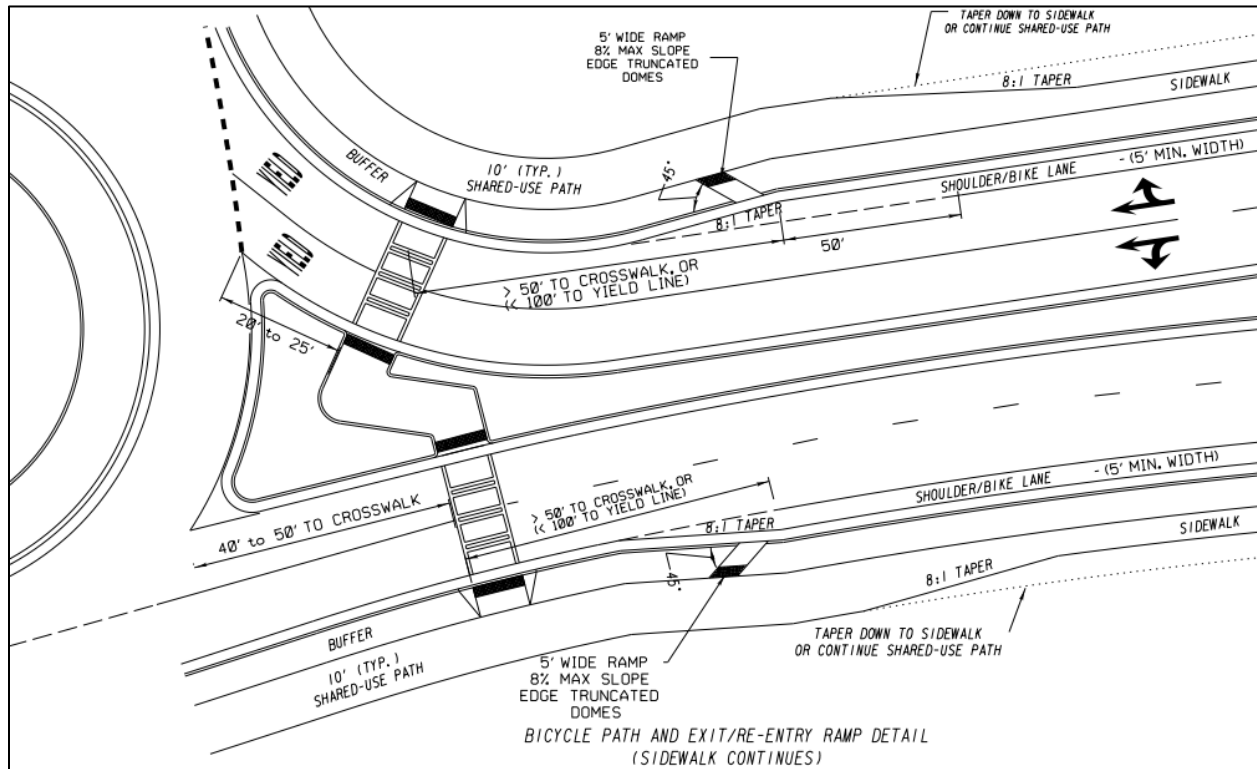


Figure 3-3. Bicycle Path Exit and Entry with Extended Sidewalk

CHAPTER 4 – TRAFFIC CONTROL DEVICES

The traffic information system, consisting of regulatory, warning and navigation signing and marking is an essential contributor to safe and efficient operation of roundabouts. This chapter illustrates application of the standards and guidelines presented in the GDOT Signing and Marking Design Guidelines (DPM Chapter 13), that must be used in the design of roundabout traffic signing and pavement markings prepared for the Georgia Department of Transportation (GDOT). See Figure 4-1 and Figure 4-2 for the sign sequence and marking patterns typically associated with single lane and multilane roundabouts.

4.1 SIGNING

Similar to conventional intersections, signing at roundabouts includes regulatory signs, warning signs and guide signs. Section 13.2 of the GDOT Signing and Marking Design Guidelines covers signing at roundabouts. The required signs are covered in the following sections of the Signing and Marking Guide:

- Advanced Warning Signs W2-6 and W13-1P 13.2.1
- Yield Signs R1-2 13.2.2
- Guide Signs D1-5 or D1-3d, M5 (State Route Shields) 13.2.3
- Lane Use Signs R3-8 series or R3-6 series 13.2.4
- Pedestrian Signs W11-2 and W16-7P 13.2.5

RECTANGULAR RAPID-FLASHING BEACONS

RRFBs are typically activated by a pedestrian pushbutton. The flashing display is associated with identifying the presence of a pedestrian by drivers and may result in increased yielding. Designers should consult with the Office of Traffic Operations for the warrants for the use of RRFB's where roundabouts are located in an area with high pedestrian volumes.

4.2 MARKING

Section 13.3 of the GDOT Signing and Marking Design Guidelines covers pavement marking at roundabouts. The required pavement marking items are covered in the following sections of the Signing and Marking Guide:

- Yield Line 13.3.1
- Yield word marking 13.3.2
- Arrows on multilane approaches 13.3.3
- Pedestrian crossing 13.3.4

RUMBLE STRIPS

High build thermoplastic rumble strips should be placed in rural roads and high-speed approaches of 50 mph or greater. Rumble strips should not be used in residential areas or extend across the shoulder or bike lanes where cyclists would be impacted. Refer to construction detail T-19 for installation.

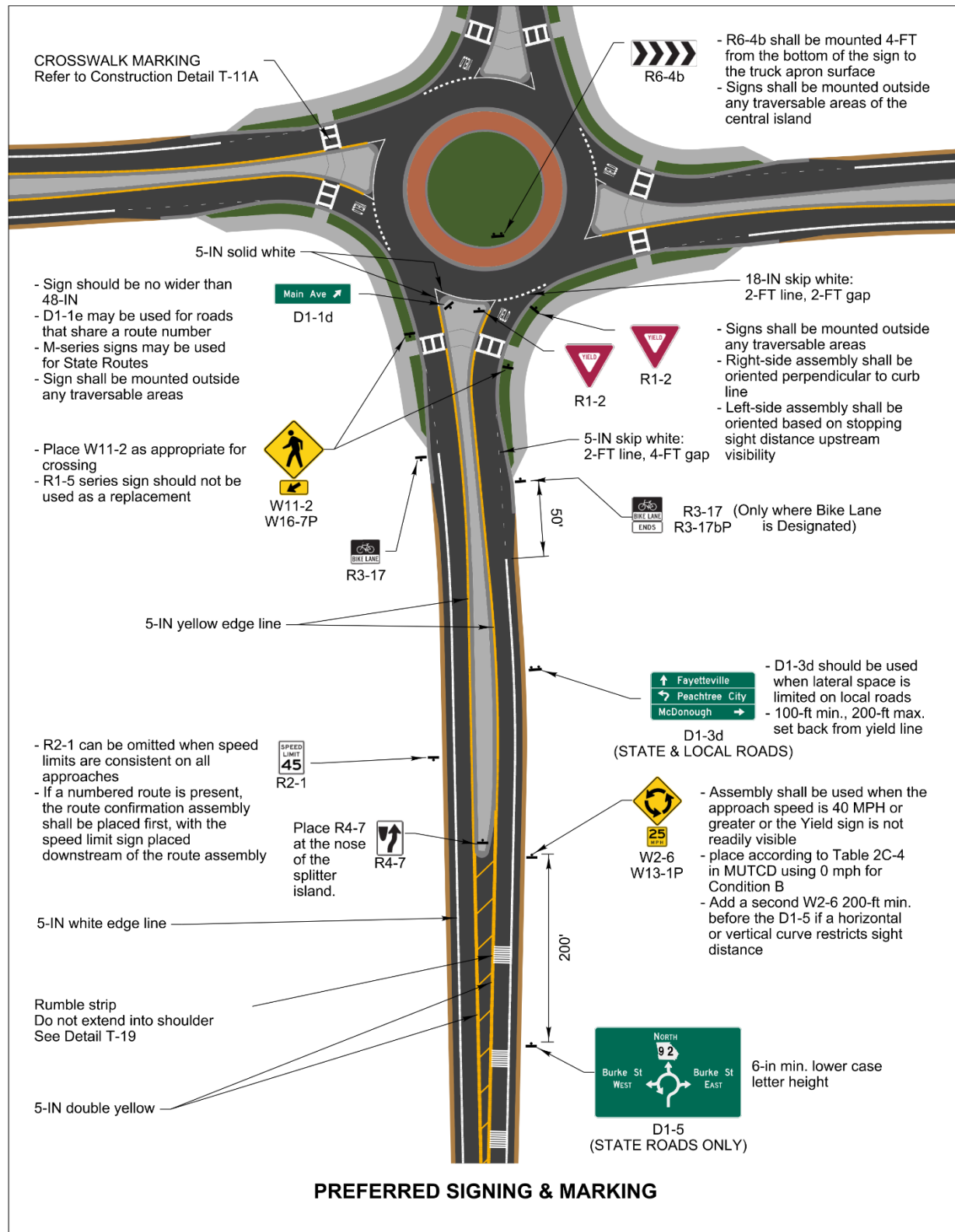


Figure 4-1. Single Lane Roundabout Signing and Marking

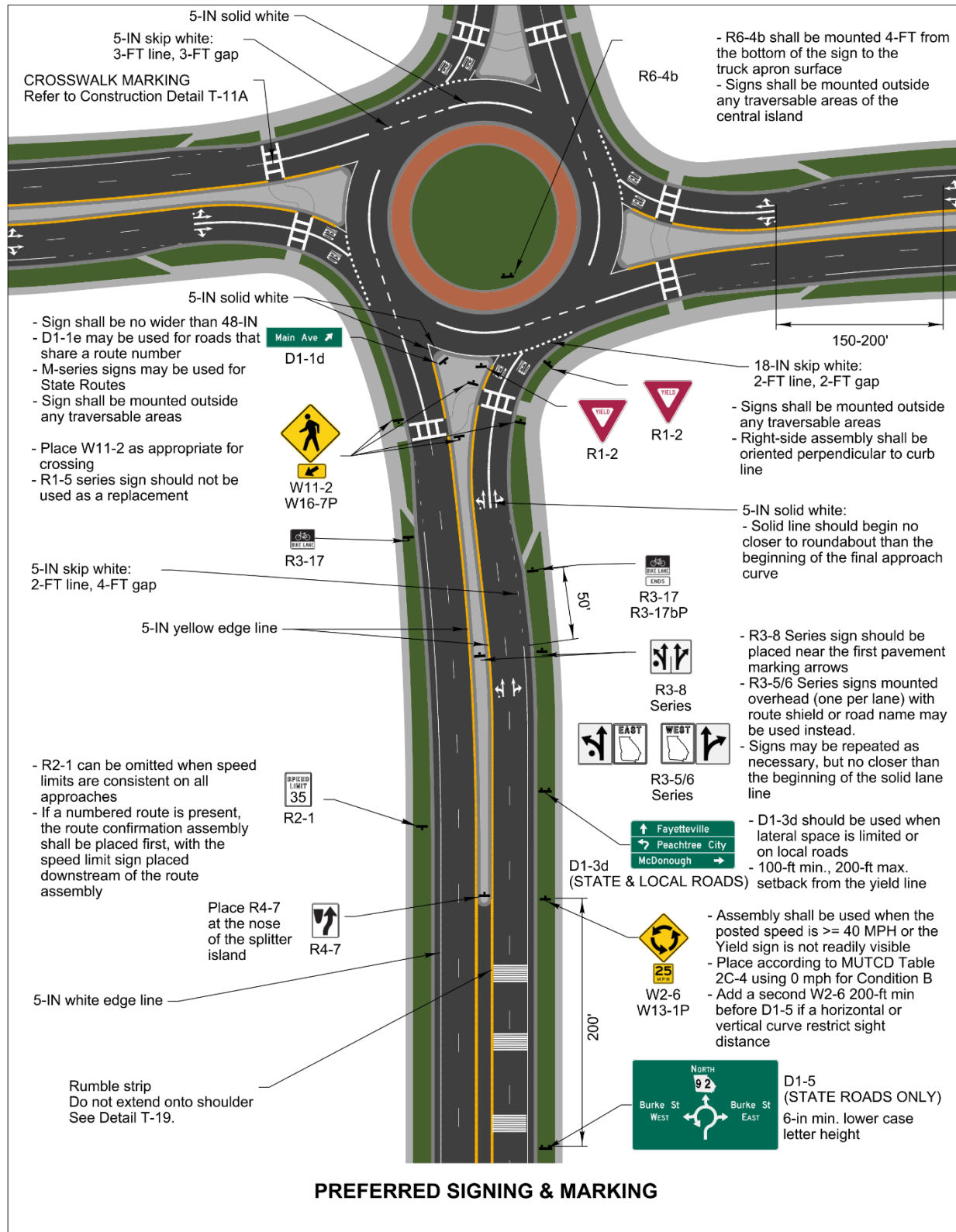


Figure 4-2. Multilane Roundabout Signing and Marking

CHAPTER 5 – LIGHTING

5.1 PRINCIPLES

The critical areas that require illumination are the entering/circulating conflict points, crosswalks, and transition points from pavement to raised channelization. If the approaching roadways are not continuously illuminated, transition lighting may be required. Refer to Section 14.3.3 of the GDOT DPM. GDOT is exploring ways to reduce the number of light poles on roundabouts by using other visibility elements such as illuminated bollards and raised pavement markers. Roundabout designers are encouraged to consider reduced lighting using supplemental visibility elements subject to approval by the Office of Design Policy.

Lighting plans should be developed consistent with the guidelines presented in ANSI/IES RP-8-18 Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting; Roadway Lighting and Chapter 14 of the DPM.

5.2 POLE PLACEMENT RECOMMENDATIONS

An important function of lighting at a roundabout is to ensure that any pedestrian in the crosswalk is visible to vehicles approaching, entering, and exiting the roundabout. Roadway lighting also provides increased safety to cyclists, at the approach to the roundabout where they mix with vehicular traffic; and, throughout the circulatory roadway where they may be integrated into the traffic stream. For these reasons, it is recommended that lighting be placed around the perimeter of the roundabout at locations upstream of the crosswalks, such that pedestrians are in positive contrast (front-lit). This is confirmed in the analysis by the vertical illuminance calculation. Poles should be located to provide consistent lighting levels around the circulatory roadway. See Figure 5-1 for a basic example of pole placement.

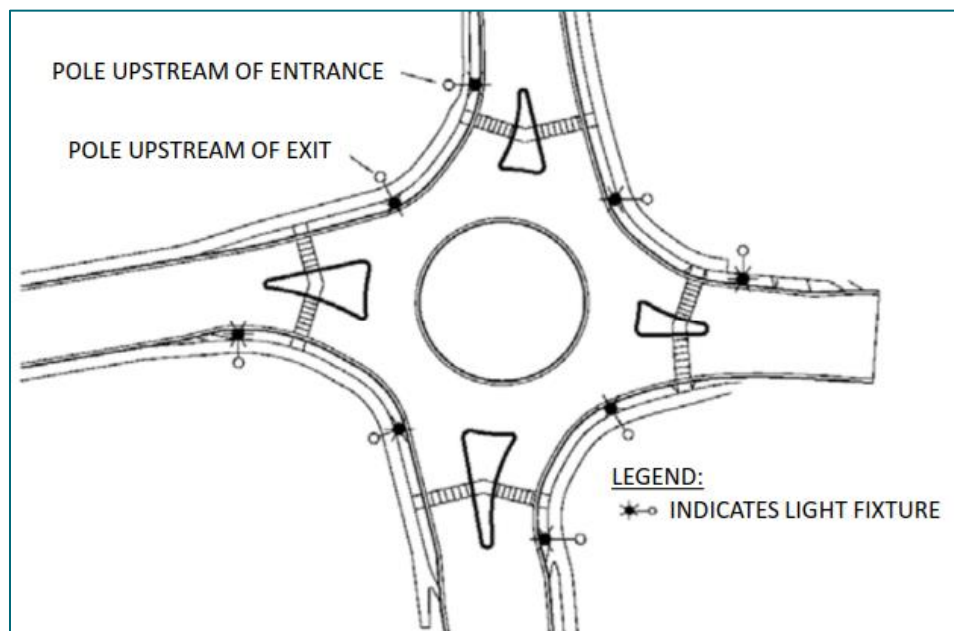


Figure 5-1. Perimeter Pole Placement

CHAPTER 6 – LANDSCAPING AND MATERIALS

Landscaping a roundabout can improve aesthetic value and increase the visibility of the roundabout from a distance. If minimal or no landscaping is planned for the central island, it should be mounded with soil to a height of 4 ft. to 6 ft. and seeded for low maintenance. Mounding of the central island is common, especially for rural locations where intersection visibility is essential for positive guidance.

Where a central island is to be landscaped through an agreement with the local government, sight distance is the primary criterion governing treatments used on roundabouts. Allowances for planting and placement of fixed objects are categorized as either restricted or unrestricted as determined by intersection and stopping sight distance envelopes (discussed in sections 2.11). Trees with mature caliper size of greater than 3 inches should be avoided. Consult with the Office of Traffic Operations if fixed objects are to be considered in central island landscaping.

Guidance for trees and shrubs allowed on state routes is found in Policy 6755-9 Policy for Landscaping and Enhancements on GDOT Right of Way. Additional guidance is provided in the GDOT Pedestrian and Streetscape Guide. Use GDOT Construction Detail RA-1 and the project's sight distance study for landscaping a roundabout central island.

Contrasting colors are recommended for truck apron color versus surface colors for non-traversable such as splitter islands and buffer areas behind curb and gutter. The GDOT approved color for a concrete truck apron is FHWA Insignia Red (FS 11136 9B2F25).

Mountable areas may be textured with a stamped brick pattern, or a simple broom finish which adds skid resistance but does not convey the wrong message to motorists that the truck apron is non-traversable as are other patterned concrete surfaces such as splitter islands.

CHAPTER 7 – PAVEMENT DESIGN

7.1 PAVEMENT TYPE SELECTION

Pavement type selection at a roundabout is determined by the existing pavement type, projected traffic volumes, and constructability during staging. Choice of pavement design, particularly the riding surface is dependent on traffic factors mainly, but preference is given to asphalt for multilane roundabouts where the contrast of pavement marking for lane lines and directional arrows is essential for safe operation. Refer to the Pavement Design Manual for additional guidelines on pavement type selection.

7.2 AXEL LOADING ANALYSIS

The heaviest circulating volume (per lane for multilane) is to be used for axel loading analysis. Roundabout circulating volumes are defined as the traffic that circulates upstream from an approach's first exit but before the next entry, i.e. opposite the splitter island face. It is the sum of an approach's U-turns, left turns and through volumes, and the upstream approach's U-turns and left turns, and the further upstream approach's U-turns. The highest volume circulating traffic figure governs the axle loading calculation.

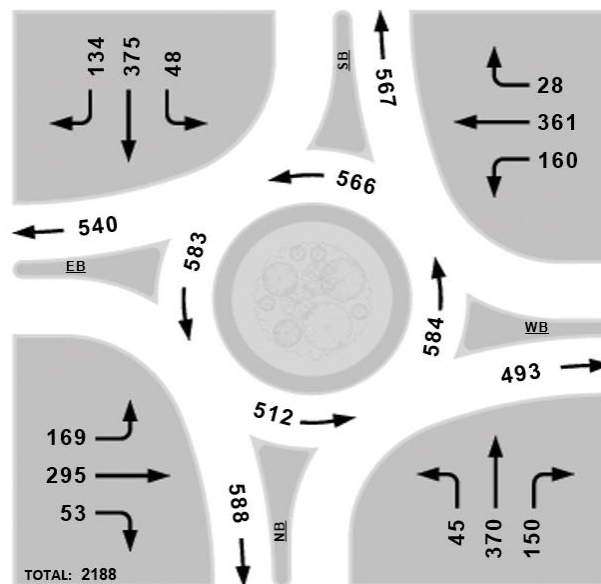


Figure 7-1. Circulating Volume Calculation

CHAPTER 8 – CONSTRUCTION STAGING

A well-planned construction staging process is key to minimizing disruption and ‘construction fatigue’ – the tiresome experience of contending with the effects of construction on traffic and access. Maintaining existing traffic movements during construction of a roundabout can be very complex and may require multiple stages. Closure of the intersection and detouring traffic should be considered if there is a feasible detour route available.

The best-practice principles that apply to all roundabout construction staging and traffic management are as follows:

- Attempt to achieve circulating traffic, i.e. getting the intersection to operate as a roundabout as soon as possible. It reduces speeds, improves capacity and improves safety for workers.
- Minimize the number of stages to avoid ‘construction fatigue’, excessive duration and excess cost.
- Minimize the changes to traffic control on the roundabout. Avoid changing from yield to stop control and back again, to manage stages where traffic needs to use parts of the circle. Avoid running traffic in the contra-flow direction on the roundabout.
- Days if not weeks before the roundabout opening, attempt to have the normal priority rules of yielding at entry with traffic flowing counterclockwise.
- Signing, including way-finding (D and M series signs) should be installed before the roundabout opens and especially lane designation signs for multilane roundabouts.
- Use changeable message boards on each approach at the time of opening and for reasonable duration after opening. Advise using an alternating message of: “New Control” and “Yield Ahead”.

8.1 ALTERNATIVE CONCEPTS FOR STAGING ROUNDABOUT CONSTRUCTION

The purpose of this guidance is to inform the designer of practical construction staging alternatives. Construction duration adds costs to projects, but intersection closure is not feasible in many cases. The alternatives presented herein represent a range of cases that are possible depending on the intersection context and constraints. Alternatives are presented below, in order of the increasing cost of maintenance of traffic and space requirements. There may be sub-alternatives to these general category options. These include but are not limited to:

1. Closure of the intersection with a traffic detour for part or most of construction duration
2. Partial Detour (close the cross road or one leg)
3. Short term (weekend) closure of the intersection with a traffic detour
4. Construction of the roundabout under traffic (undivided 2-lane roadway)
5. Construction of the roundabout under traffic (divided 4-lane roadway)
6. Construction of a roundabout off alignment

ALTERNATIVE 1 – LONG-TERM CLOSURE OF THE INTERSECTION WITH A TRAFFIC DETOUR

If there is an acceptable detour route, closing the roads to traffic and allowing the contractor the entire area to construct the roundabout allows the most efficient and cost-effective construction process.

Provide a detour plan subject to consultation with the District Traffic Engineer. Properties with driveways within the construction limits will still need access during the construction.

ALTERNATIVE 2 – PARTIAL DETOUR (CLOSE THE CROSS ROAD)

This alternative is appropriate where the main road must remain open, but the minor route can be detoured.

Stage 1 (Figure 8-1)

Close and detour traffic on south leg. Construct temporary widening along the south side of the mainline for future traffic switches. Complete full construction of the south leg. Construct as much as possible of the roundabout quadrants and circulatory roadway.

Stage 2 (Figure 8-1)

Shift mainline traffic onto temporary widening and open the south leg to traffic. Close and detour traffic from the north leg. Complete full construction of north leg. Construct as much as possible of the roundabout quadrants and circulatory roadway. Construct westbound mainline approaches. Construct temporary pavement for traffic switches

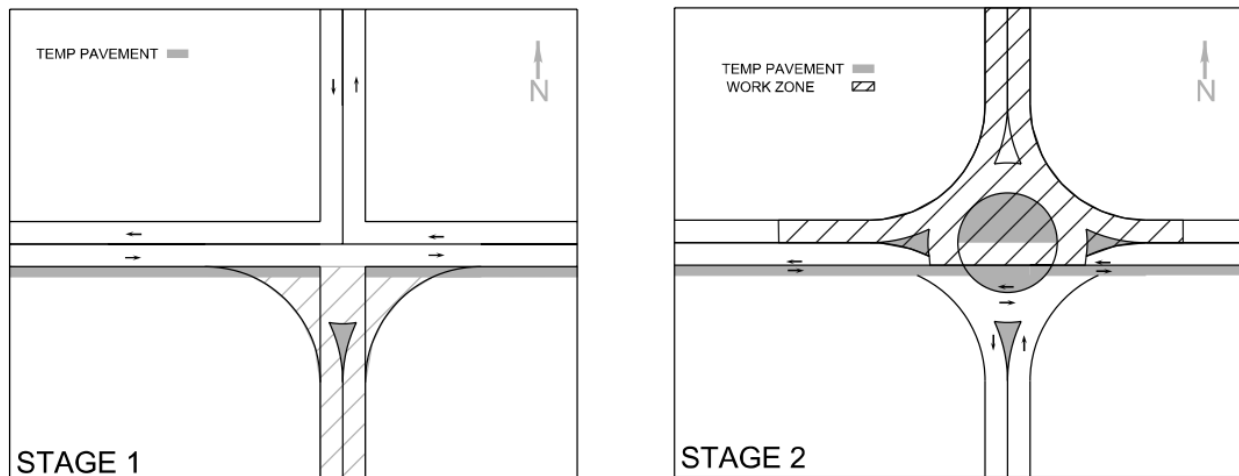


Figure 8-1. Alternative 2 - Stage 1 and 2

Stage 3 (Figure 8-2)

Shift mainline traffic on to new westbound lanes using temporary pavement in the islands. Open the north leg to traffic. Implement yield control. Complete construction of eastbound mainline approaches.

Stage 4 (Figure 8-2)

Complete construction of splitter islands and central island. Remove all temporary pavement.

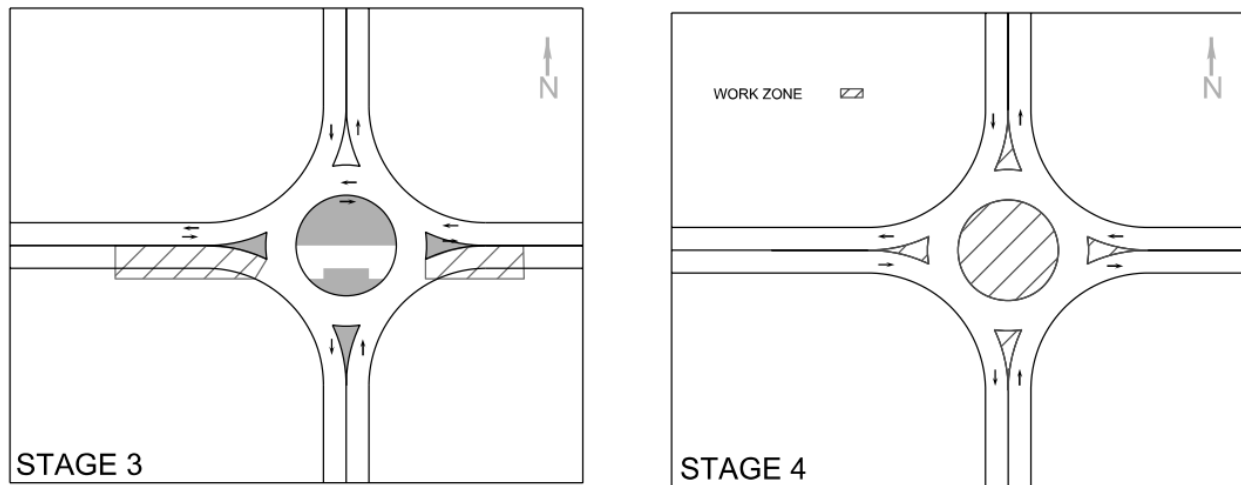


Figure 8-2. Alternative 2 - Stage 3 and 4

ALTERNATIVE 3 – SHORT TERM (WEEKEND) CLOSURE OF THE INTERSECTION WITH A TRAFFIC DETOUR

This alternative is appropriate for an intersection on two lane roads.

Stage 1 (Figure 8-3)

Construct temporary widening along the side of each roadway to move traffic off a portion of the roadway to construct the pavement in Stage 3. Traffic remains on existing lanes. Detour signing is put in place for the detour in Stage 2.

Stage 2 (Figure 8-3)

Close the intersection to traffic, rerouting traffic on to a detour. Construct as much of the intersection as possible while intersection is closed and traffic is detoured.

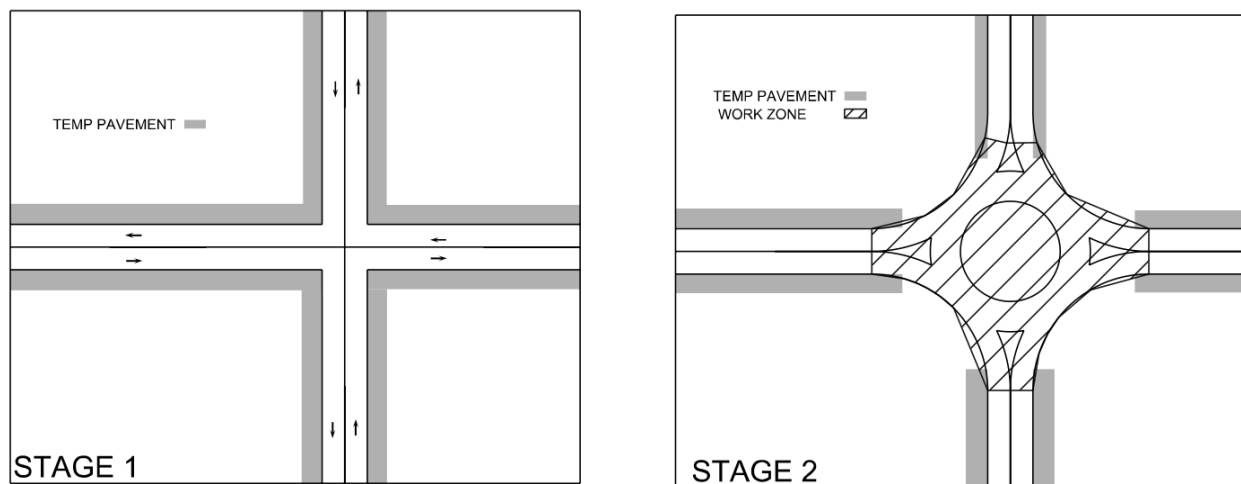


Figure 8-3. Alternative 3 - Stage 1 and 2

Stage 3

Construct the lanes in one direction on each roadway with traffic on the temporary pavement.

Stage 4 (Figure 8-4)

Shift traffic on to the new pavement and construct the lanes for the other direction. Use the shoulder and temporary pavement if necessary.

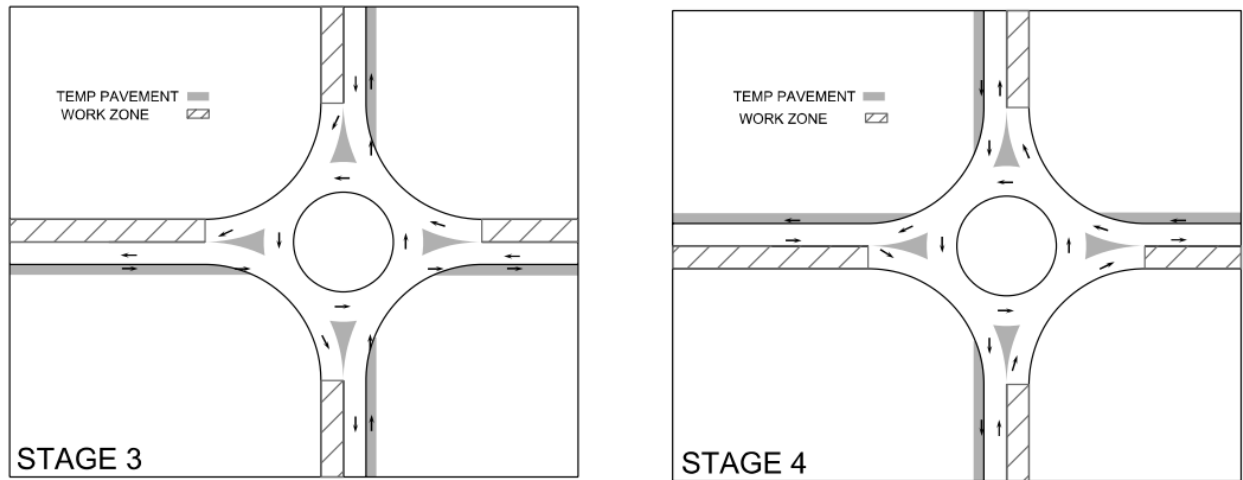


Figure 8-4. Alternative 3 - Stage 3 and 4

Stage 5 (Figure 8-5)

Construct the central island and splitter islands. Remove any remaining temporary pavement. If there are no shoulders and temporary pavement is removed from the edge of the permanent pavement, construct the outside curb and gutter.

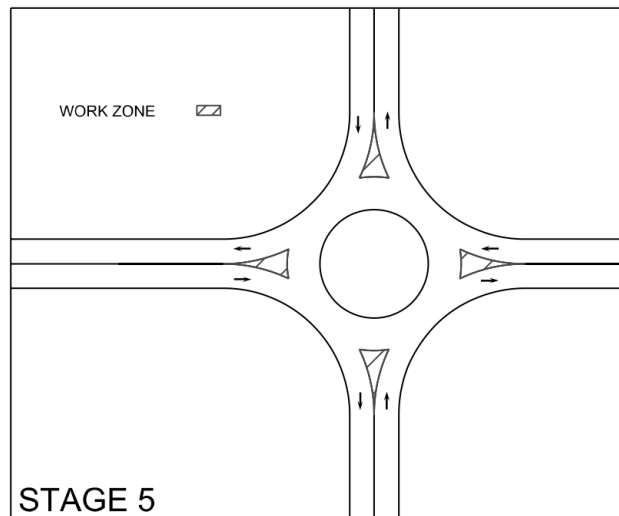


Figure 8-5. Alternative 3 - Stage 5

ALTERNATIVE 4 – CONSTRUCTION OF THE ROUNDABOUT UNDER TRAFFIC (UNDIVIDED 2-LANE ROADWAY)

This alternative is appropriate for an intersection of two-lane roads that do not have a feasible detour route available.

Stage 1 (Figure 8-6)

Construct temporary widening to one side of the roadway to accommodate traffic during the construction of the permanent pavement in stage 3. Traffic remains on existing lanes.

Stage 2 (Figure 8-6)

Construct one quadrant of the roundabout and as much of the circulatory roadway as possible.

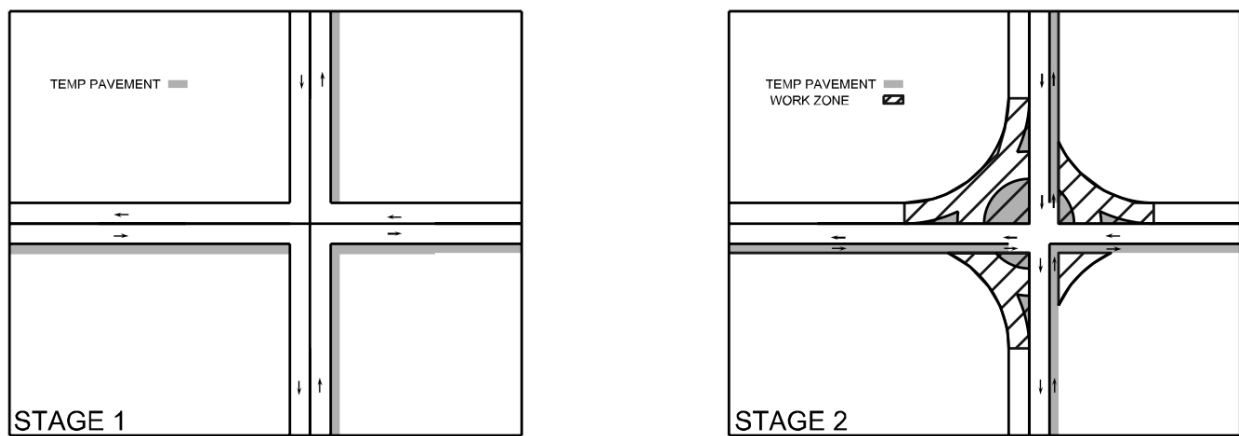


Figure 8-6. Alternative 4 - Stage 1 and 2

Stage 3 & 4 (Figure 8-7)

Construct the remaining quadrants and the circulatory roadway. Use the shoulder for a traffic lane or temporary pavement as needed to complete the roundabout construction.

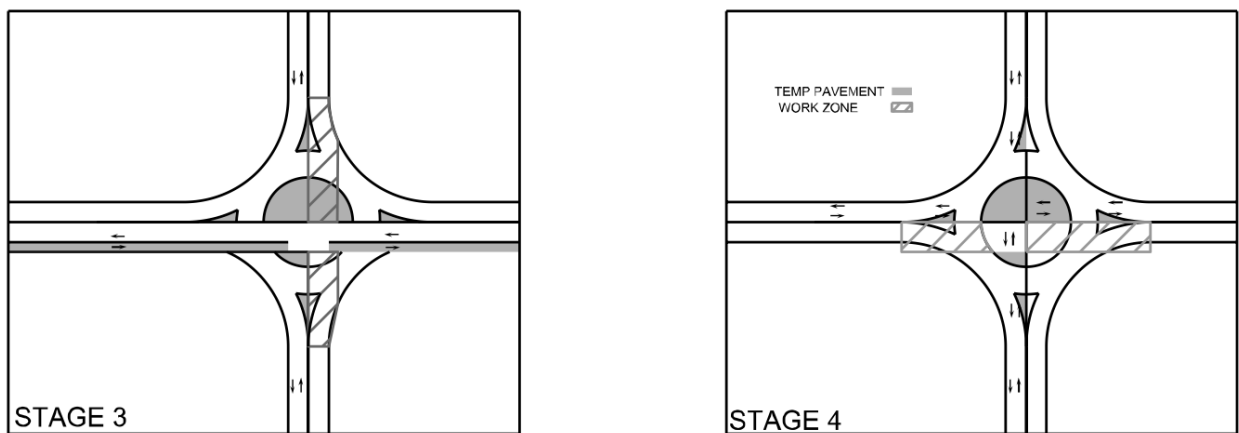


Figure 8-7. Alternative 4 - Stage 3 and 4

Stage 5 (Figure 8-8)

Construct the remaining central island and splitter islands, quadrants and the circulatory roadway. Traffic is on the newly constructed pavement. Remove the temporary pavement.

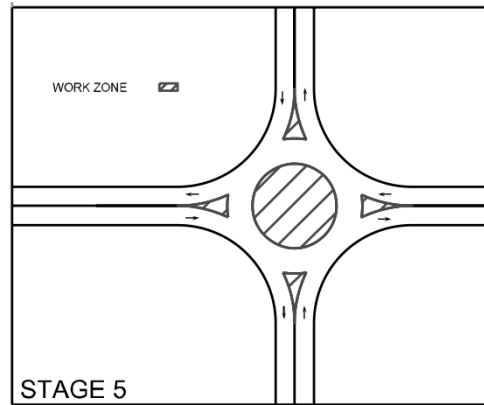


Figure 8-8. Alternative 4 - Stage 5

ALTERNATIVE 5 – CONSTRUCTION OF THE ROUNDABOUT UNDER TRAFFIC (DIVIDED 4-LANE ROADWAY)

This alternative might apply to the intersection of a four-lane divided and a two-lane road that does not have a feasible detour route available.

Stage 1 (Figure 8-9)

Construct temporary pavement along one side of the two-lane road and crossovers on the four-lane road. Traffic remains on existing lanes.

Stage 2 (Figure 8-9)

Construct one quadrant of the roundabout and as much of the circulatory roadway as possible. Construct any additional temporary pavement needed for traffic switches. Restrict traffic to one lane in each direction through the intersection.

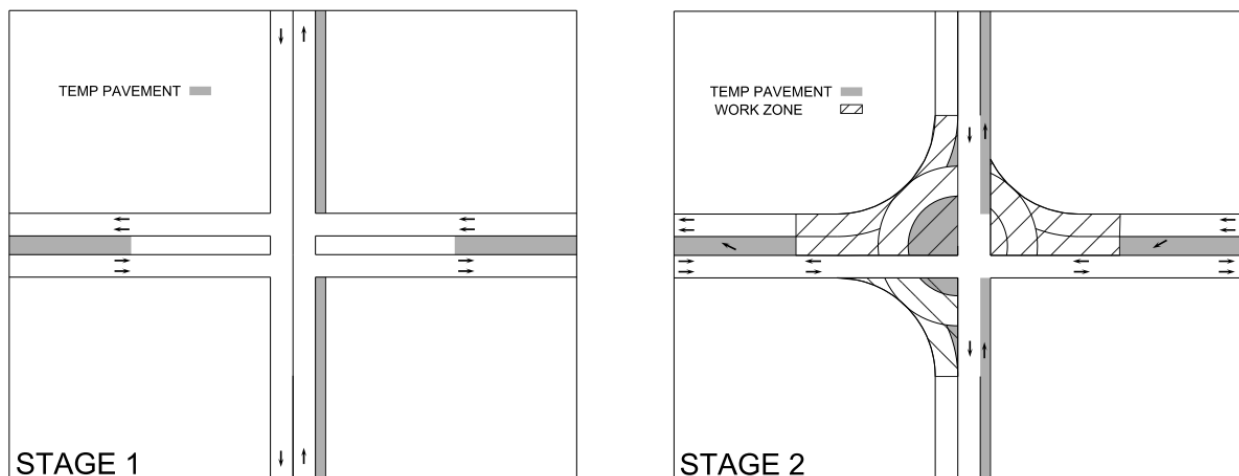


Figure 8-9. Alternative 5 - Stage 1 and 2

Stage 3 & 4 (Figure 8-10)

Construct the remaining quadrants and the circulatory roadway. Use the temporary pavement as needed to complete the roundabout construction.

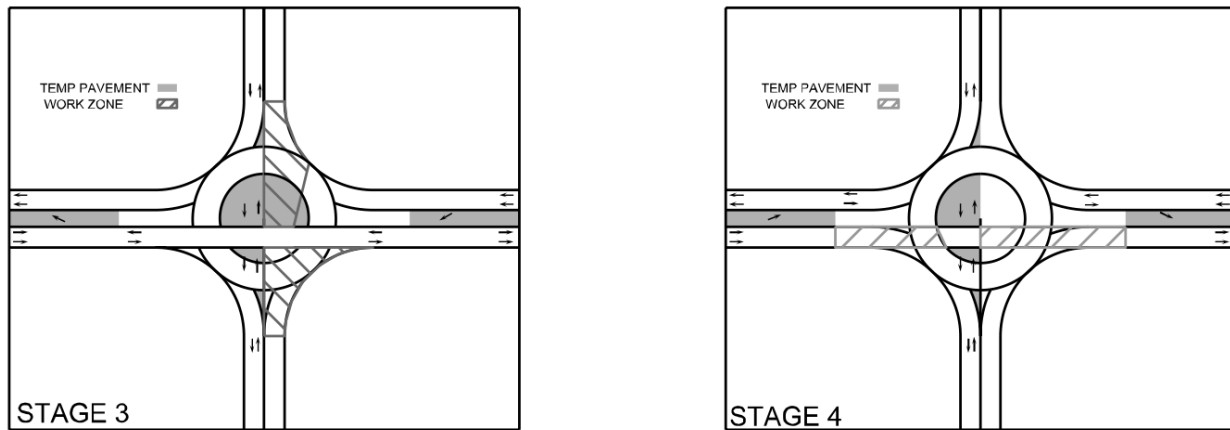


Figure 8-10. Alternative 5 - Stage 3 and 4

Stage 5 (Figure 8-11)

Construct the remaining central island and splitter islands, Quadrants and the circulatory roadway. Remove the temporary pavement.

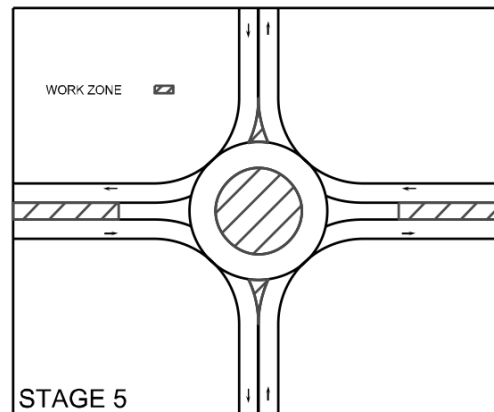


Figure 8-11. Alternative 5 - Stage 5

ALTERNATIVE 6 – CONSTRUCTION OF A ROUNDABOUT OFF ALIGNMENT

This alternative is appropriate for construction of a roundabout with the circle shifted off the existing intersection.

Stage 1 (Figure 8-12)

Construct temporary widening to one side of the roadway to move traffic off of a portion of the roadway to construct the pavement in stages 2 and 3. Traffic remains on existing lanes.

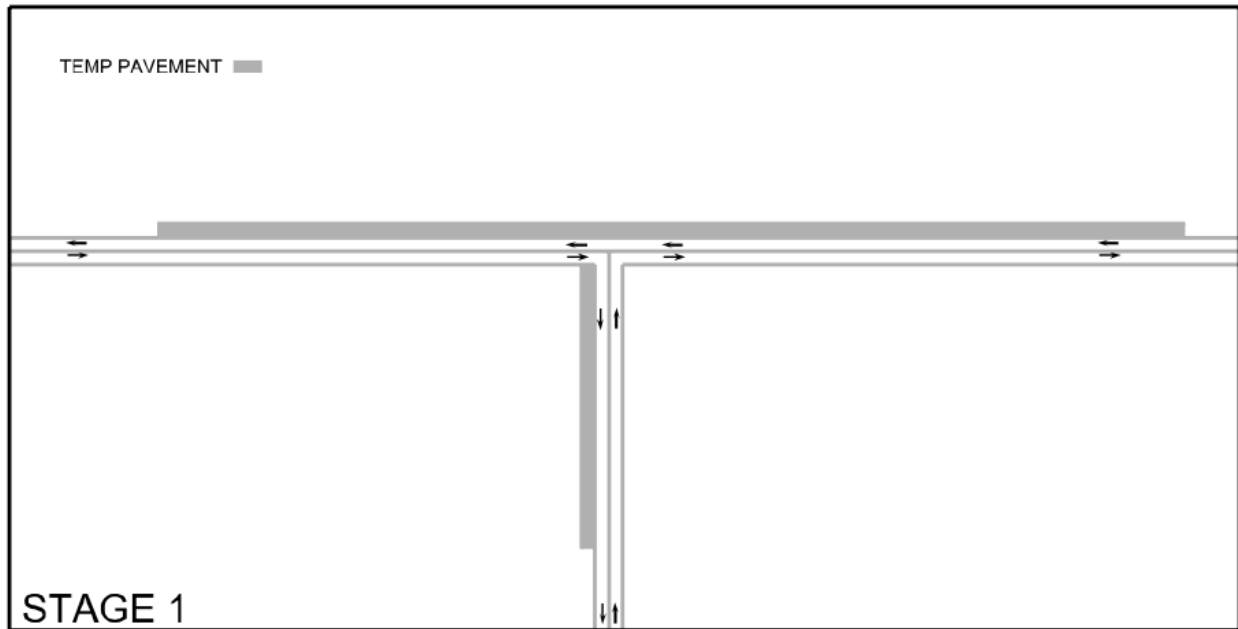


Figure 8-12. Alternative 6 - Stage 1

Stage 2/3 (Figure 8-13)

Shift traffic and construct roadway on new alignment. Construct as much of the circulatory roadway, central island and splitter islands as possible. Construct additional temporary pavement for future traffic shifts.

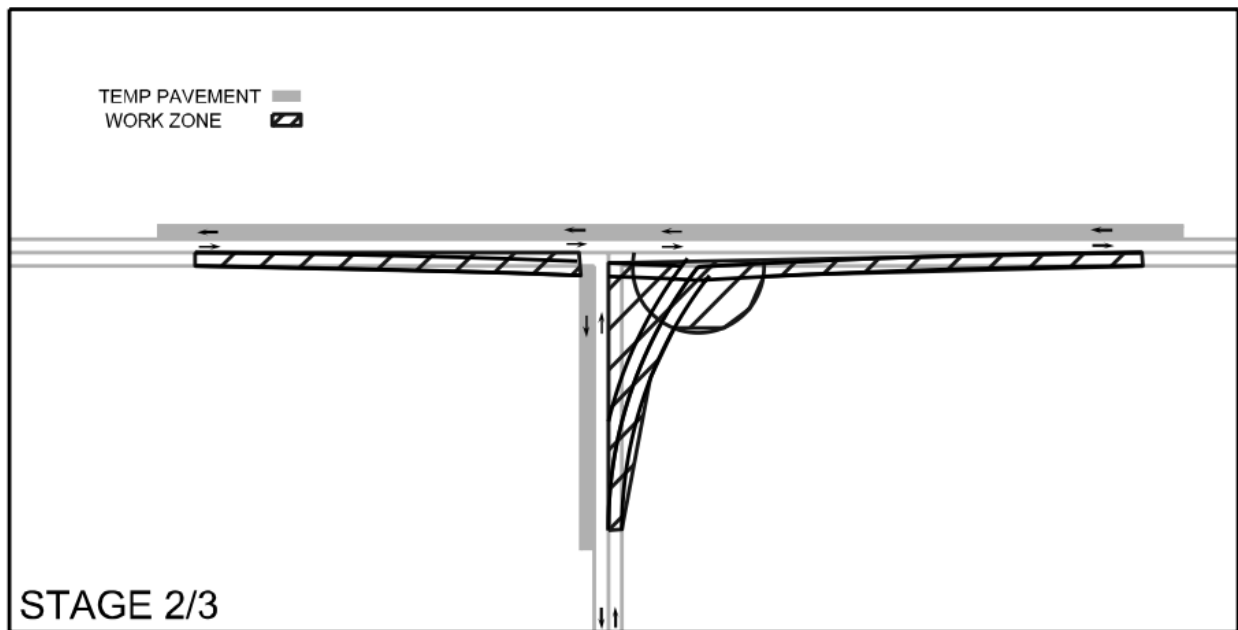


Figure 8-13. Alternative 6 - Stage 2 and 3

Stage 4/5 (Figure 8-14)

Construct remaining roundabout not constructed in earlier stages. Remove all temporary pavement once all the new roadway is constructed.

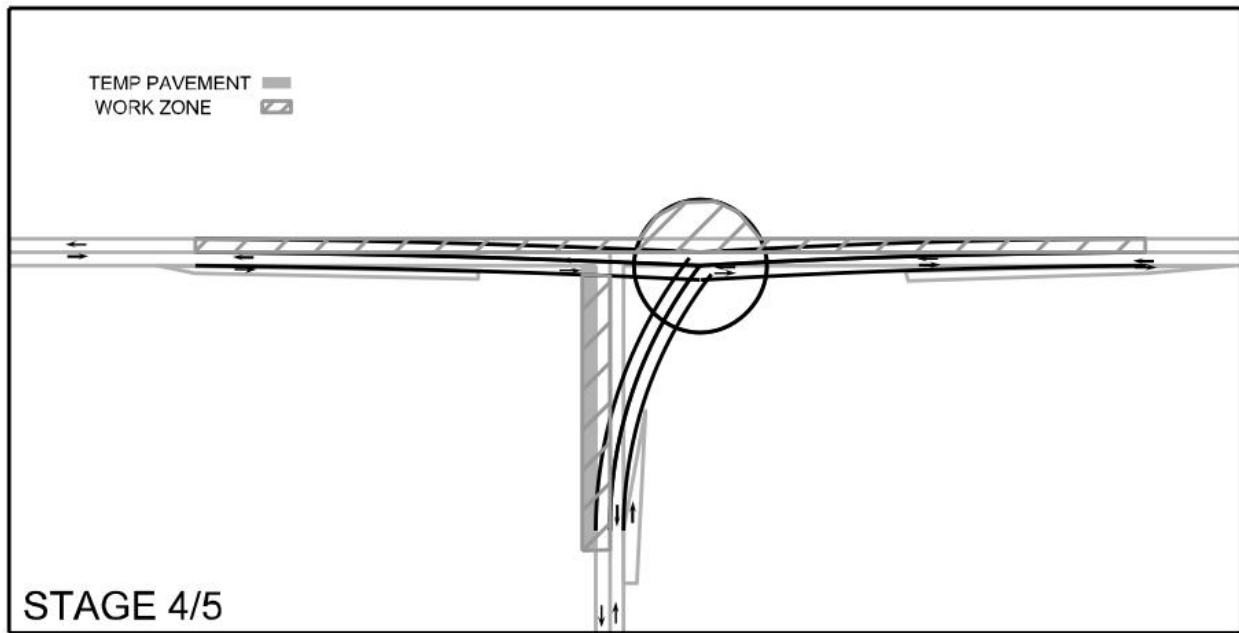


Figure 8-14. Alternative 6 - Stage 4 and 5